MODERN USES OF CONCRETE.

SCIENTIFIC AMERICAN

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Vol. XCIV.—No. 19.
ESTABLISHED 1845.

NEW YORK, MAY 12, 1906.

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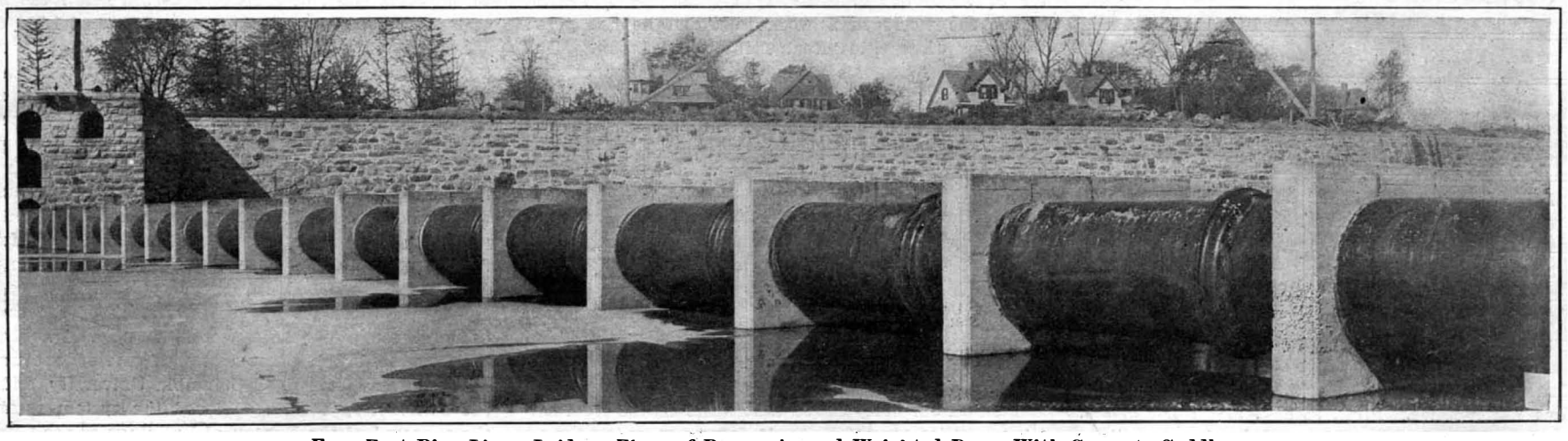
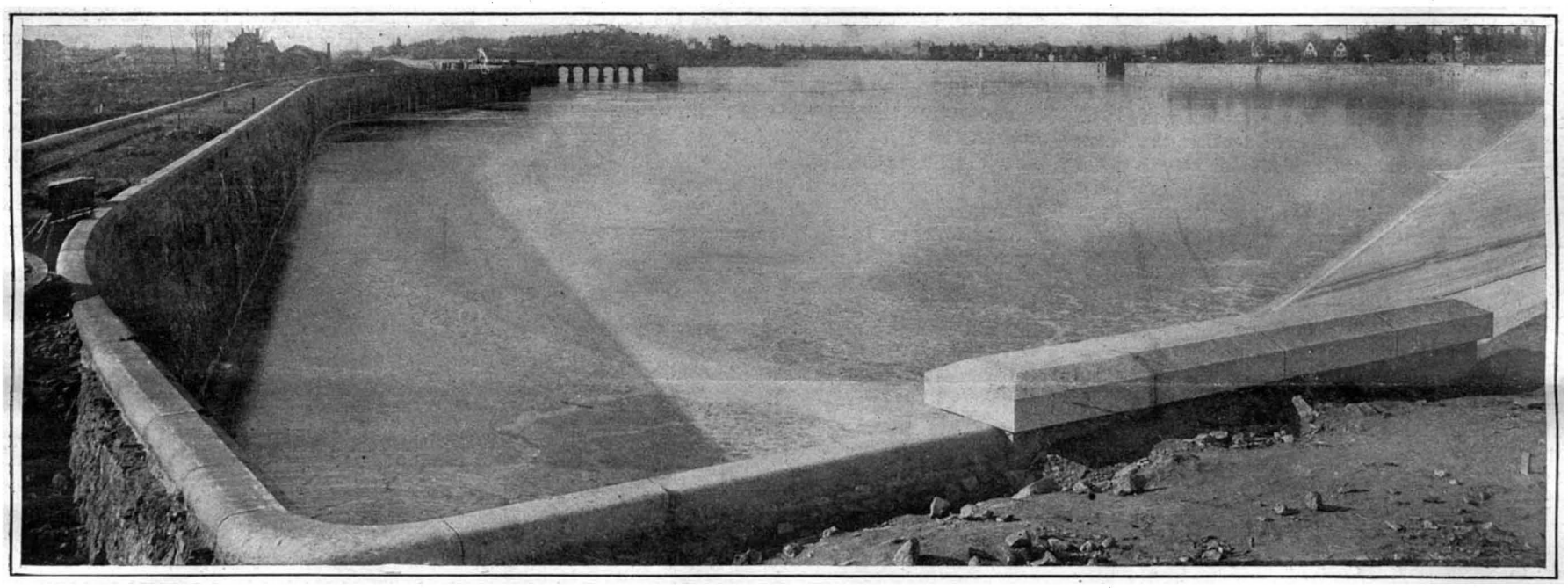
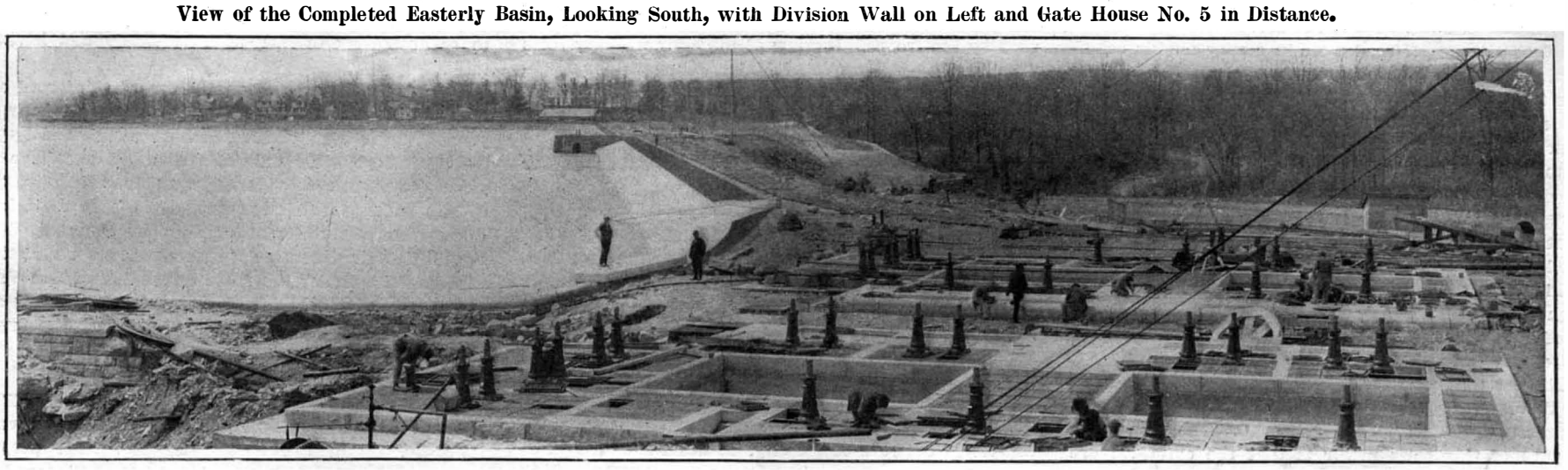


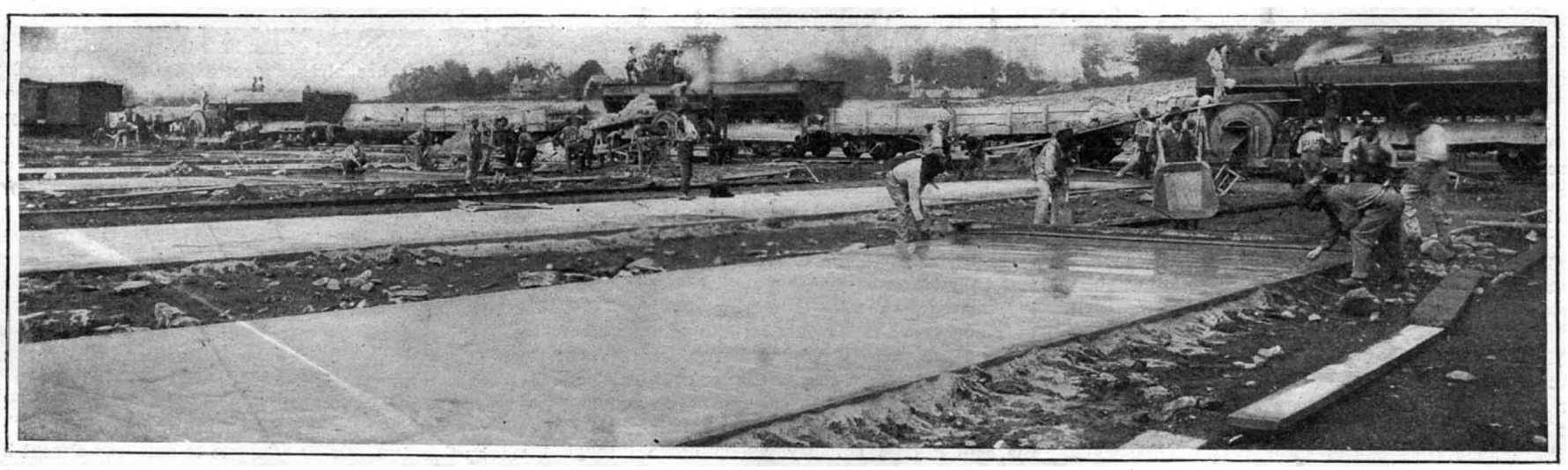
Four-Foot Pipe Lines, Laid on Floor of Reservoir, and Weighted Down With Concrete Saddles.



View of the Completed Easterly Basin, Looking South, with Division Wall on Left and Gate House No. 5 in Distance.

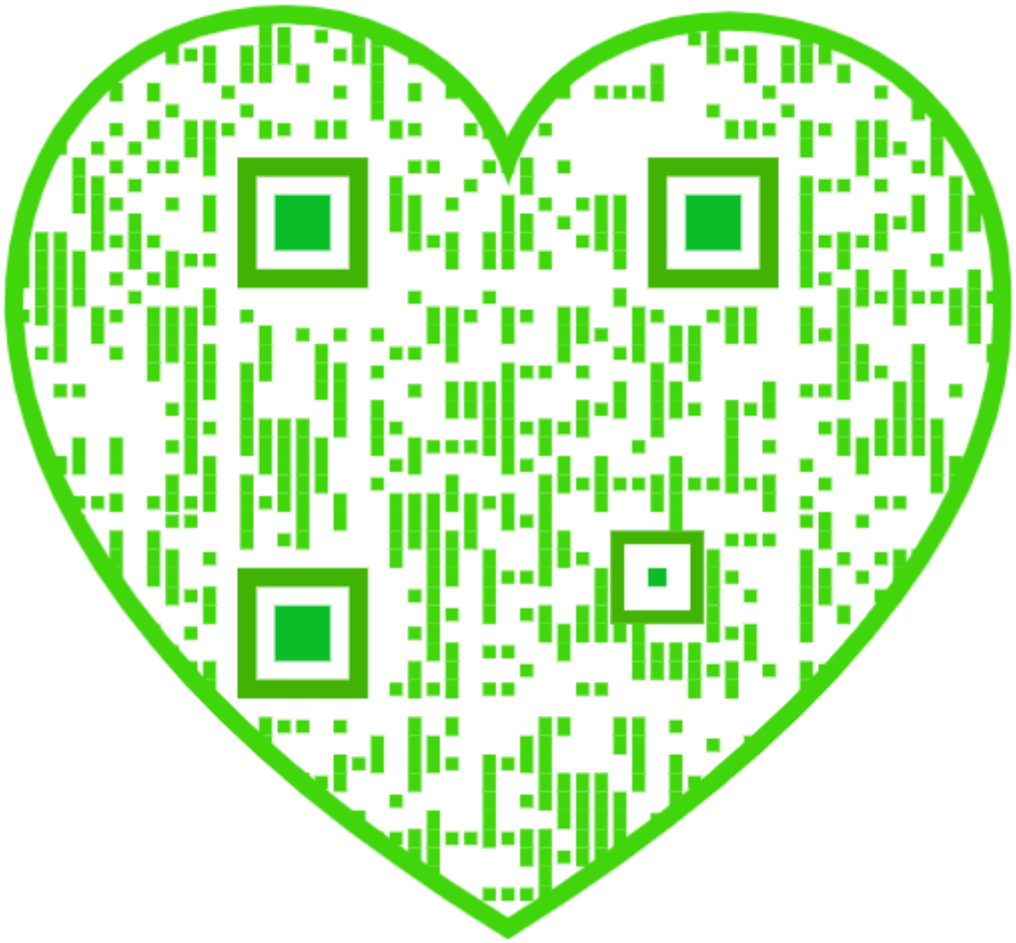


The Foundations of Northerly Gate House No. 7 Through Which Aqueduct Water is Distributed to the Reservoir.



Concreting the 101.25 Acres of the Reservoir Surface, Showing Mixers, Cars of Material, and Method of Laying.

CONCRETING THE JEROME PARK RESERVOIR.—[See page 386.]



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ESTABLISHED 1845

MUNN & CO., - - Editors and Proprietors

Published Weekly at

No. 361 Broadway, New York

TERMS TO SUBSCRIBERS

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Scientific American (Established 1845)..... .....$3.00 a year
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MUNN & CO., 361 Broadway, New York.

NEW YORK, SATURDAY, MAY 12, 1906.

The Editor is always glad to receive for examination illustrated articles on subjects of timely interest. If the photographs are *sharp*, the articles *short*, and the facts *authentic*, the contributions will receive special attention. Accepted articles will be paid for at regular space rates.

A FUEL EFFICIENCY TEST OF AUTOMOBILES.

Never before has there been held in this country an automobile contest having so many participants as had the Two-Gallon Efficiency test, conducted by the Automobile Club of America on Saturday of last week. Not only were the entries seventy-one in number, but the proportion of starters was large, there being sixty-five machines in all. The main object of the test was to determine the fuel consumption per mile of the various automobiles. First, second, and third prizes, consisting of a valuable gold punch bowl and a silver cup and medal, were awarded to the three cars that made the highest scores.

The score of each car was obtained by multiplying the total weight of the car when loaded (to which weight 800 pounds were arbitrarily added) by the distance run. Thus, in reality, the contest was placed on the ton-mile basis, which would cause the large, heavy cars to win over those of lighter weight if the former were not handicapped. This, it seemed, must be so, since ordinarily gasoline consumption does not increase directly with the weight, and a heavy car is found to be much cheaper to run per ton-mile than a light car. Despite this well-known fact, the committee in charge penalized the light cars by taking the weight of all two-cylinder machines as but 75 per cent of their actual weight, and that of the single-cylinder cars as but 70 per cent. The test favored the heavy four-cylinder cars, therefore, and it seemed well-nigh impossible that any other type of car could win. The surprising result was, however, that the winner happened to be a four-cylinder *light-weight runabout of the air-cooled type*, a car which is a distinctively American invention. This machine, weighing with driver and observer 1,500 pounds, ran from 57th Street and the East River to North Haven, Conn., a distance of 87 miles, upon two gallons of gasoline, at an average speed of 17½ miles an hour. When the fact is considered that the first 35 miles of road were in a very muddy condition, owing to a cloudburst occurring while the car was traversing them, it seems quite possible that a distance of 90 miles, or 45 miles per gallon, could have been covered had the road been dry. The automobile editor of this journal, who had the pleasure of being the observer on the winning car, believes that this distance could readily have been covered in fair weather and with dry roads, in view of the facts that the low speed had to be used on a considerable number of hills that could otherwise have been mounted on the high gear, and that the dampness of the air necessitated the opening of the needle valve of the carbureter more than is required on a pleasant day.

The car that won the second prize was likewise one of the latest types of air-cooled cars that American ingenuity has devised and perfected. The distinctive feature of this car's motor is that the cylinders are incased in aluminium jackets, through which air is forced by a powerful gear-driven blower, while in contradistinction to this system the motor of the winning runabout is cooled only by the natural draft of air as the car moves forward, the motor in this case being placed transversely at the front of the car and also being provided with auxiliary mechanically-operated exhaust valves, to aid in the quick expulsion of the burnt gases. The needle valve of the carbureter also can be adjusted from the driver's seat. This is a very good feature, that is found on scarcely any other make of car. Both of these machines are familiar to our readers from descriptions published in our automobile number of January 13 and previously. A car of the same make as the winner holds the transcontinental record, which was made in less than 33 days.

The car which obtained third place was a well-known French make of 4-cylinder water-cooled machine. This car had a score of 180,642, as against the 200,100 of the winner and the 194,953 of the second car. It weighed 3,110 pounds, and covered 46.2 miles, while the second car weighed 3,270 pounds, and made 47.9 miles. The cost of running per ton-mile of the first six cars, figured with fuel at 20 cents per gallon, is 0.613, 0.517, 0.556, 0.559, 0.500, and 0.640 of a cent respectively. The fourth machine was a large French car with a record for fuel economy; the fifth was an 18-passenger bus; and the sixth a light tonneau having the same make and size of engine as the winner. A one-cylinder buckboard made 101.6 miles, and a single-cylinder tonneau carrying four people, 56.8.

PREVENTION AND MASTERY OF DISEASE.

It is probable that most of us have heard more or less about the remarkable success which attended the efforts of the Japanese to prevent and control disease among their armies in Manchuria; but it has remained for Major Louis L. Seaman to place the full facts before the world in a work to which he has given the appropriate title "Real Triumph of Japan." The high reputation of Major Seaman as an army surgeon, and the fact that his assertions are based upon personal observation during his presence with the armies in Manchuria, place the statements contained in his work, extraordinary though they be, beyond all question as to their veracity and accuracy.

It is shown by Longman's Tables that for nearly two centuries past, in wars that extended over any great period of time, on an average at least four men have perished from disease to every one who has died of wounds. In the late Boer war 8,221 officers and men were sent home on account of wounds, while 63,644 were invalided home by disease. Major Seaman quotes from Vital Statistics for 1898, in which the Surgeon-General of our army shows that while deaths from battle casualties were 293, those from disease amounted to 3,681, or 14 from disease to 1 from casualty. These surprising figures are compared with the record made by the Japanese. The Japanese statistics show that from February, 1904, to May, 1905, although 52,946 were killed or died from wounds, only 11,992 died from various diseases. That is to say, only one died from sickness to every four and one-half men who died in battle or from wounds.

This complete reversal of the statistics of the two leading nations of western civilization constitutes, according to Major Seaman, the real triumph of Japan; for it is a fact that in their war with China only ten years before, the Japanese lost about the same average as that which prevailed during our own civil war, namely, three from disease to one from bullets. In that war they realized that disease was even more fatal than the enemy's weapons, and in the intervening years they set out to master the invisible foe with a success to which the statistics, as above given, bear eloquent testimony. These results were obtained by careful study of military sanitation and hygiene, and by a most thorough bacteriological examination of the water along the line of march and in the vicinity of the camps. The water-testing outfit formed part of every sanitary detachment, and every foraging and scouting department was accompanied by a medical officer, who made an examination of the water to be used by the troops. In view of the extraordinary facts developed as the result of Major Seaman's investigation, it is not putting the case too strongly to say that, as matters now stand, the medical corps has as much, if not more, to do with the winning of campaigns and the mitigation of the horrors of war as any other department of the army.

FIREPROOF QUALITIES OF REINFORCED CONCRETE.

In a recent issue we drew attention to the fact that, because of its strength, resiliency, and monolithic or one-piece construction, reinforced concrete was admirably adapted to resist the shock of earthquakes, and we strongly recommended the system for the rebuilding of San Francisco. We now wish to emphasize the fact that armored concrete is equally well adapted to resist the fierce heat of such a conflagration as that which completed the ruin of the city. Mention should first be made, however, of certain additional facts which have come to light regarding the behavior of reinforced concrete buildings that were exposed to the most destructive shocks of the earthquake. The first case is that of the bell tower of the Mills Seminary, which, although it is some 75 to 80 feet in height, was not even cracked by the severe shaking to which it was subjected. The other two instances are to be found in Stanford University, where the Museum Building and Roble Hall, both built of reinforced concrete, are standing practically intact amid the widespread ruin, and in some cases the absolute demolition, of the other buildings of the University, all of which were massively constructed with a special view to withstanding earthquake shock. Two wings built of brick had been added to the Museum Building since its completion. These were thrown down, while the concrete structure passed through the ordeal satisfactorily. Roble Hall is built with concrete walls and floors of wood. The only damage to this building was due to the falling of a chimney, which broke through the floors, killing one of the inmates.

As to the ability of reinforced concrete to stand the test of fire, although there are no advices at hand to show that any such construction was put to severe fire test in San Francisco, enough has been learned in experimental tests made for building departments, and particularly in an exceedingly fierce fire which occurred to a concrete building in Bayonne, N. J., three or four years ago, to render it certain that buildings of this type would have passed through even the San Francisco ordeal satisfactorily.

One of the most conclusive tests by fire, loading, and water was that made last year by the Bureau of Buildings of New York city of a reinforced concrete floor, carried on two reinforced concrete girders, supported by four columns. The purpose of the test was to determine the effect of a continuous fire below the floor of four hours at an average temperature of 1,700 deg. F., the floor carrying a load of 150 pounds per square foot. At the end of four hours, the red-hot floor was to be subjected to a stream of cold water for five minutes, and then the upper side of the floor was to be flooded at low pressure. As the result of the test there was some flaking of the surface of the concrete, which did no material damage to the building. A stream of water knocked off the concrete from the bottom at one of the girders at the center, exposing the metal rods for a few feet, and there were some slight cracks of no material significance. With the exception of these defects, the whole floor system, in spite of the severe ordeal through which it passed, was found to be in excellent condition. The test was carried out under Prof. Ira H. Woolson, of Columbia University, and on the satisfactory results achieved the system received the approval of the Bureau of Buildings of the City of New York, for whom the test was made.

But the most severe test, the one which is generally accepted by engineers and architects as proving on a large scale the fire-resisting qualities of reinforced concrete, was the fierce fire which burnt out the mill of the Pacific Coast Borax Company at Bayonne, N. J., on the night of April 6, 1902. The building, which measured 200 feet by 250 feet, was four stories high in the main portion, and the remainder consisted of a single-story wing. The fire, which started from the bursting of an oil main and was fed by a large amount of inflammable material, was an exceedingly hot one; as was proved by the amount of fused cast iron from the machinery and copper from the dynamos and motors, which was found on the various concrete floors (themselves intact) after the conflagration. Everything that the building contained was completely burnt up, and nothing but the monolithic concrete structure remained. This was found to be in absolutely perfect condition, so much so that the building was put in first-class shape at a cost of less than one thousand dollars. Evidence of the ability of such a structure to pass through a severe fire test, and yet maintain its integrity, was found in the fact that although the heat must have exceeded 2,000 degrees, the side walls, four stories high and 200 feet long, without any cross walls to tie them, were found, at the conclusion of the fire, to be absolutely in line, both vertically and horizontally.

The question of the extensive use of reinforced concrete in the rebuilding of San Francisco is greatly dependent upon the attitude which may be taken by the San Francisco labor unions, which hitherto have opposed the system so vigorously and successfully, that of late but little of it has been used. We note, however, from press dispatches, that the unions have signified their intention to suspend all restrictions which might hinder the rapid rebuilding of San Francisco, and it is to be hoped that this conciliatory and humane attitude will be extended to cover the important question of constructive materials.

THE GOVERNMENT AS A CEMENT MANUFACTURER.

The government wants Portland cement, and wants it badly. With twenty-four big irrigation projects under construction, requiring hundreds of thousands of barrels of cement, the engineers are finding it next to impossible to obtain anything like the quantity needed. The unprecedented demand for this commodity all over the West has already overtaxed the capacity of the mills, and almost without exception the government's requests for bids are turned down. Apparently no manufacturers west of the Mississippi are able to supply new orders. In reply to inquiries from the government they state that owing to the unusual demand, new orders cannot be accepted for several months to come. Recently proposals were requested from eight manufacturers and dealers in cement for 2,000 barrels required on an Idaho project. Only one proposal was received, and that was at a rate fifty per cent higher than the firm would have sold a few months ago. Still later invitations for bids for several thousand barrels were sent to twenty-three dealers. Again but one firm submitted a bid, and this was nearly sixty per cent higher than the normal profitable rate of sale by this firm. Other attempts to purchase cement have been similarly unsuccessful.

The Reclamation Service is gravely concerned. It

has let contracts for structures involving millions of dollars, and a failure to secure cement as needed, entering as it does so largely in the work, will be disastrous. Owing to the inaccessibility of many of the government works, the transportation of cement is difficult and costly. This was particularly the case in Salt River Valley in Arizona, where the great distance from existing mills and the expensive wagon haul made the cost prohibitive. After making thorough investigation of the cost of bringing in cement for the Roosevelt Dam and other structures, the government erected its own mill, and for several months past has been turning out daily hundreds of barrels of first-class cement at a price far below the cost of cement shipped in. It is known that materials required for manufacturing cement of good quality exist near several of the other projects, and private parties should embrace the opportunity to go into the business. From the present outlook, however, the government seems to have a choice of shipping from the far eastern seaboard or from Europe, or of manufacturing its own cement.

SOME FEATURES OF THE GREAT EARTHQUAKE.

BY H. A. CRAFTS.

I was afforded an excellent opportunity to observe the effects of the great California earthquake of April 18, 1906, being in San José at the time of the shock Then, in about an hour, I left for San Francisco over the Southern Pacific Coast line, which traverses the west shore of San Francisco Bay from Palo Alto on the south to the center of the city on the north.

At San Bruno, fifteen miles south of San Francisco, the train was halted on account of damaged track, and the great majority of the passengers started on afoot. As for myself, I walked about twelve miles, when I was overtaken by the train which had finally managed to creep across the shaken track and proceed on its way.

I then went as far as the Valencia Street station, in the southern quarter of San Francisco. At that point I ascertained that it would be impossible to get through the city and across the bay to Oakland; and having started for the last-named point to learn the fate of my family, I concluded to turn back and proceed to San José, or wait at some small town on the peninsula until such time as I could make my way *via* San Francisco.

I walked back some five miles, and then took a train back to San José, arriving there at six o'clock P. M., just twelve hours from the time of my departure. Meantime I had traveled fifty miles of the worst-affected territory and returned.

I am of the opinion that when the relative force of the earthquake has been approximately measured, it will be found that the point of greatest energy was in the vicinity of San José. I am quite sure from my personal observations that the shock at San José was much more severe than that at San Francisco.

There is no point that apparently received so severe a shock as San José and some of the smaller towns next north of it on the peninsula, excepting Santa Rosa, and that town is almost exactly the same distance north of San Francisco as San José is south. Thus San Francisco might be taken as the center of the disturbance, with a constantly-increasing force both north and south for distances of fifty miles, from whence outward the force constantly diminished.

Now as to the disturbance in an easterly and westerly direction: The next day I took a train for Oakland, on the east side of the bay, and was surprised to observe that that strip of country had been far less affected than the strip that I had traversed the day before. There were a few chimneys down along the route, and when I reached my home in Fruitvale, a suburb of Oakland on the southeast, there was hardly any evidence that an earthquake had struck the section the day before.

Of course, the effect westward of San Francisco could not be judged, because there is the boundless Pacific; and if there were any upheaval at all, it came in the shape of a tidal wave, and I have yet to hear that any such phenomenon occurred in that direction. Eastward still of Oakland there was a constantly diminishing tremor. Stockton, sixty miles inland from the Golden Gate, reported but a comparatively slight disturbance. So there is the approximate area of the great terrestrial disturbance.

Now as to local effects. At the time of the shock I was in bed in a small room in the rear of the second floor of a large square-frame dwelling on North Third Street, San José. I had wakened some fifteen minutes before, and was trying to get one more nap before arising. Suddenly I was aroused from a half-slumber by the sound of a rush and a roar outside, and in a second the whole house was swaying from side to side and straining in every part.

Then there was a momentary lull, after which came the supreme shock. The house appeared to heave up and down and sway from side to side at the same time, just as if it had been suddenly cast upon a rolling sea. The terrible force appeared to gain strength continually, and it seemed as if the whole structure would be wrenched in pieces and flung to the ground in a heap of ruins. In the meantime the roar outside had become almost deafening, and this was punctuated with crash after crash of falling buildings in distant parts of the town.

Then all was calm, and that calm was almost as terrifying as the storm that had just ended, for who could tell what was coming?

Upon rising I found my washstand, which had stood back against the east wall of the room, moved out from the wall at its south end about a foot, while all around the carpet was drenched with water that had been spilled from a large ewer that had stood in a bowl upon the washstand.

Hastily dressing, I went into the street. The sky above was perfectly clear and the sun was just rising. The air was balmy, and not a breeze stirred the leaves upon the trees. Looking up and down the streets, a gray dust could be seen rising, not only from the earth itself, but from the wreckage that strewed the whole city.

I turned the next corner going west, and came suddenly to a large square two-story frame dwelling, that had had its back broken at the second floor joist and had yawed off to one side, the first story meantime half collapsing and the upper story resting upon it intact. Hovering around its portals were some half dozen half-clad, distracted women, and I heard one of them remark that they had all got out alive, and that there had been eight persons in the house at the time of the shock.

That was a sample of some of the work done in San José. I did not remain to inspect the town, but hurried to the train. When I returned in the evening, a friend told me that San José was a wreck. This should be qualified, however. There was hardly a building in town that did not show some effects of the earthquake. Not one chimney in a hundred was standing. The business part had been more badly damaged than the residence part; hardly a front was intact, while many buildings had entirely collapsed. About thirty persons had been killed, including several entire families.

I took the 6:10 train for San Francisco, and it was a continuous succession of wreckage all the way up the track. There are about a dozen fair-sized towns between San José and San Francisco, including Santa Clara, Palo Alto, Redwood City, and San Mateo. Santa Clara was hit fully as hard as San José, but no one was killed. At Palo Alto the buildings of the Leland Stanford, Jr., University were badly wrecked, At Redwood City the new courthouse was about ruined.

Either coming or going I caught glimpses along the principal business streets of these towns, and there were regular windrows of ruins stretching up either side of the streets as far as there were any buildings of a considerable size.

The railroad as far as San Bruno was in fairly good condition, but it must be remembered that it is built over a very low and level tract of country, with no filled grades to speak of. But north of San Bruno there are several arms of the bay marsh lands reaching up into the peninsula, and across these the railroad company was compelled to construct grades that vary from four to ten feet in height above the marsh level.

Here it was that the earthquake put in some of its heavy licks. The earth embankments were sunk and cracked and the track twisted into serpentine shape for long distances.

And presently we came to the great cemeteries where the dead of San Francisco have been buried for fifty years. Thousands of headstones and monuments were overturned, and the elaborate gateways wrecked in various ways. Here I had a talk with a railroad employe who lives in the vicinity. He informed me that when the shock came, he was on his way to the small station to draw a pail of water. The motion of the earth was so violent that he was thrown off his balance, and he fell to the ground.

He said, however, that he was not very badly scared until he looked over into the cemeteries, and there saw "all the gravestones dancing a jig," to use the man's own language.

Now let us refer briefly to the various topographical characteristics of this region: San José stands about midway east and west in the upper end of the Santa Clara Valley. About twelve miles east stands the inner coast range, and about the same distance to the west stands the Santa Cruz or outer coast range. Neither of these ranges was badly shaken. San José stands about ten miles south of the southern extremity of the bay of San Francisco and upon a level plain composed of an alluvial soil.

The peninsular towns mentioned are at about the same level, but the outer coast range swings eastward, so that the valley land narrows down rapidly as one goes north.

The district traversed on the east side of the bay is also at about the same level, and forms a comparatively narrow strip of land between the bay and the inner coast range.

Some might say that the terrible peninsula was the point of greatest insecurity, but San José, quite a distance south of the base of that arm of land and in the midst of a landlocked valley, got just as bad a shaking as did the peninsula.

THE ADVANTAGES AND LIMITATIONS OF REINFORCED CONCRETE.

A paper read by Mr. Charles S. Hill before the Association of Portland Cement Manufacturers so admirably reviews the merits and defects of reinforced concrete that it may not be deemed amiss to summarize it here.

The capacity of resistance to tension of concrete, says Mr. Hill, is much less than the ultimate compressive resistance; when a concrete beam, for example, is subjected to transverse loading, it fails by tearing apart on the tension side. The purpose of the combination of concrete and steel known as reinforced concrete is to supply the deficiency of tensile strength in concrete—to make possible the construction of a beam or other member almost entirely of concrete, but which shall, by having imbedded in it steel rods of desired shape and suitable cross-sectional area in proper positions, possess a high capacity to take tensile stresses. The fundamental theory of the combination is that the disposition of the concrete and the steel in the section is such that the two elements act as a single unit, all stresses being divided between the concrete and the steel where the latter occurs.

Actual construction of reinforced concrete falls somewhat short of reaching this theoretical perfection; it is not possible to distribute the steel perfectly through the concrete nor is it possible to secure that absolute adhesion between the concrete and steel which is necessary to perfect transmission of the stresses from one material to the other. These defects have to be allowed for in practical design; they may be reduced to quite minute proportions by good design and good workmanship, and they may be so accentuated by poor design and poor workmanship that a weak and dangerous material results.

Premising reasonably good design and workmanship, the claims which reinforced concrete presents as a structural material are sound and important. The compressive resistance of concrete is about ten times its tensile resistance, while steel has about the same strength in tension as in compression. Volume for volume, steel costs about fifty times as much as concrete. For the same sectional areas, steel will support in compression thirty times more load than concrete, and in tension three hundred times the load concrete will carry. Therefore, for duty under compression only, concrete will carry a given load at six-tenths of the cost required to support it with steel. On the other hand, to support a given load by concrete in tension would cost about six times as much as to support it with steel. If, then, the various members of a structure are so designed that all the compression stresses are resisted by concrete and steel is introduced to resist the tensile stresses, each material will be serving the purpose for which it is cheapest and best adapted and one of the principles of economic design will be fulfilled. This is the economic claim which reinforced concrete presents as a structural material.

Other important advantages secured in the combination of concrete and imbedded steel are: that the protection of the metal elements from corrosion is practically perfect; that the fire and heat resisting qualities of a masonry structure are secured at about the cost of a more or less temporary unprotected steel structure. That concrete is an almost perfect protection of steel from corrosion, is a fact almost beyond reasonable dispute. Both theory and the evidence of actual experience support this statement. It is to be noted, however, that concrete, to be effective in preventing rusting, must be dense, without voids and cracks, and in close contact with the metal at all points. The fire-resisting qualities of concrete have been subjects of much dispute. Theoretically, concrete being a hydrated compound should disintegrate with the expulsion of the water of hydration by heat. Practically, however, such disintegration must be very slow because of the high temperature required to drive off the water and because of the poor heat conductivity of the material. To set against whatever weakness concrete may have in the respect mentioned, we have the indisputable evidence that concrete structures have met the requirements of the most severe municipal fire tests and have successfully withstood the attacks of actual conflagration.

The rapid growth of reinforced concrete in public favor has been little short of marvelous. It is now used for nearly every form of structure for which timber, steel, or masonry is suitable. Indeed, its greatest evil is that it has been crowded into uses for which there is small warrant for its adoption as compared

(*Continued on page* 387.)

TYPICAL SYSTEMS OF REINFORCED CONCRETE CONSTRUCTION.

Of the interesting features of modern civil engineering, interesting because of their extreme novelty and successful application, reinforced concrete is probably most noteworthy because of its unique adaptability. How striking is the influence of steel reinforcement is best exemplified by a reference to Fig. 1. There two beams are shown designed to carry ordinary floor loads, the one made entirely of concrete and the other of concrete with a sheet of expanded metal imbedded in the tensile portion of the beam. The saving in mere weight of concrete alone is apparent; and when we remember that the adoption of floor beams entirely of concrete means an increase of thickness of nine inches, or assuming five to eight floors, an increase in the total height of the building (with extra cost of higher and heavier walls, together with heavier foundations to carry them) of from four to six feet, we see that even as regards initial outlay for materials, the introduction of steel reinforcement into concrete construction is of importance.

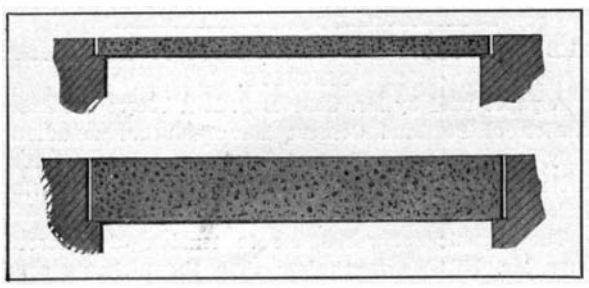


Fig. 1.—These Beams Are Designed to Carry the Same Load. The Upper is of Reinforced Concrete, the Lower of Plain Concrete.

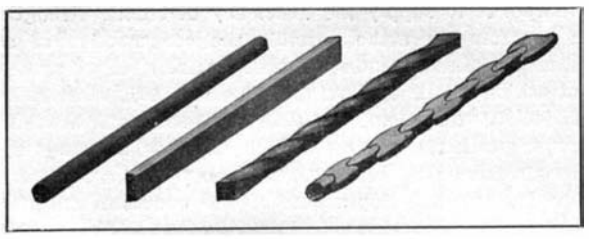


Fig. 2.—Types of Steel Reinforcing Rods.

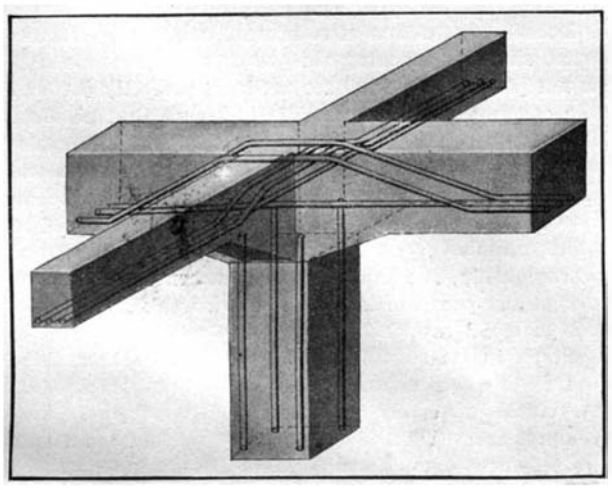


Fig. 3.—A Reinforced Concrete Pier for Railway Traffic.

So far as economy in initial cost of materials is concerned, reinforced concrete is undoubtedly cheaper than either concrete or steel alone. It is not very easy to demonstrate this economy except by comparative cost in individual cases, but an approach to a systematic comparison has been made by Mr. Walter Loring Webb, as follows: A cubic foot of steel weighs 490 pounds. Assume as an average price that it can be bought and placed for 4.5 cents per pound. The steel will therefore cost $22.05 per cubic foot. On the basis that concrete may be placed for $6 per cubic yard, the concrete will cost 22 cents per cubic foot, which is 1 per cent of the cost of the steel. Therefore, on this basis, if it is necessary to use as reinforcement an amount of steel whose volume is in excess of 1 per cent of the additional concrete which would do the same work, there is no economy in the reinforcement, even though the reinforcement is justified on account of the other considerations. Assuming 500 pounds per square inch as the working compressive strength of concrete, and 16,000 pounds as the permissible stress in steel, it requires 3.125 per cent of steel to furnish the same compressive stress as concrete. On the above basis of cost, the compression is evidently obtained much more cheaply in concrete than in steel—in fact, at less than one-third of the cost. On the other hand, even if we allow 50 pounds per square inch tension in the concrete and 16,000 pounds in the steel, it requires only 0.31 per cent of steel to furnish the same strength as the concrete, which shows that, no matter what may be the variation in the comparative price of concrete and steel, steel always furnishes tension at a far cheaper price than concrete, on the above basis, at less than one-third of the cost. The practical meaning of this is, on the one hand, that a beam composed wholly of concrete is usually inadvisable, since its low tensile strength makes it uneconomical, if not actually impracticable, for it may be readily shown that, beyond a comparatively short span, a concrete beam will not support its own weight. On the other hand, on account of the cheaper compressive stress furnished by concrete, an all-steel beam is not so economical as a beam in which the concrete furnishes the compressive stress and the steel furnishes the tensile stress. This statement has been very frequently verified when comparing the cost of the construction of floors designed by using steel I-beams supporting a fireproof concrete floor, and that of a concrete floor having a similar floor slab but making the beams as T-beams of reinforced concrete.

A good idea of reinforced concrete construction can be obtained from Fig. 3, which is an isometrical projection of a portion of a pier strong enough to carry the heaviest railway traffic. The disposition of the steel work is shown in the piles, the main girders, and beams; and the manner in which the steel rods running along the tensile or bottom side of the girders and beams are bent up over the top of the pile, which is here the tensile member (the beams being continuous), and then down again to the bottom of the girders and beams, is most instructive.

The sections of the steel employed vary in different systems, being round, flat, square, angle, and tee (Fig. 2). In all cases the simplest section is the best, as it costs less, and readily allows the concrete to be rammed into the closest contact with the entire surface of the armoring. In America the Ransome system is most extensively used—a system in which a bar of twisted steel is employed. Small sections are better than large ones, for by their use we obtain a more uniform distribution of stress in the steel; we can also readily bend and work them into any required shape; and finally, the most economical disposition of material is obtained, the metal being placed at the maximum distance from the neutral axis.

Expanded metal meshing (Fig. 6) is increasingly employed, more particularly in the lighter forms of construction. It consists of sheets of metal which have been mechanically slit and expanded, so as to produce a network. This type of reinforcement has many and obvious advantages. Its mere existence is proof of good steel, and it forms an excellent key for concrete too thin to permit reinforcement in the form of rods; thus it is very useful for concrete plaster, ceiling, and partition wall work. A good example of reinforced concrete in which expanded metal is used may be found in the Monier system (Fig. 5). An improvement on this system is the Clinton method (Fig. 11) of using an electrically welded wire netting in combination with

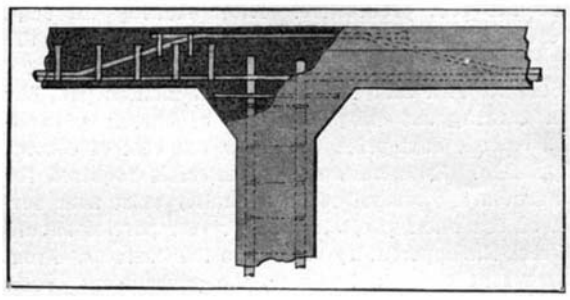


Fig. 4.—Method of Joining Columns and Floors.

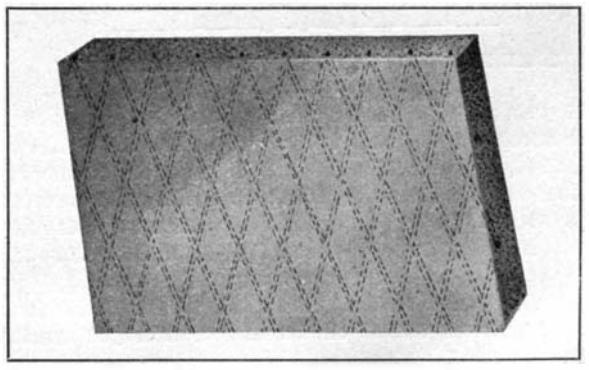


Fig. 5.—The Monier System.

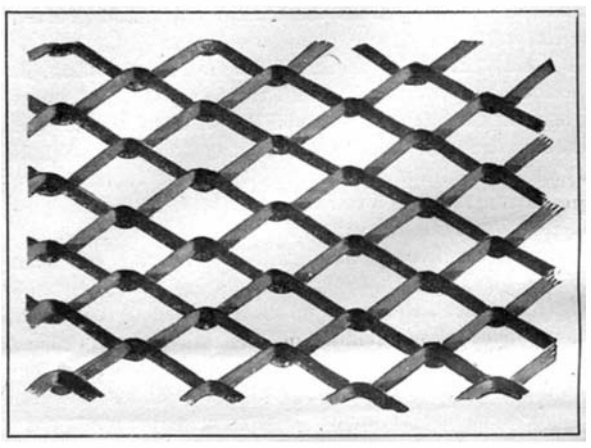


Fig. 6.—Expanded Metal.

Fig. 7.—Ransome System of Erecting Columns.

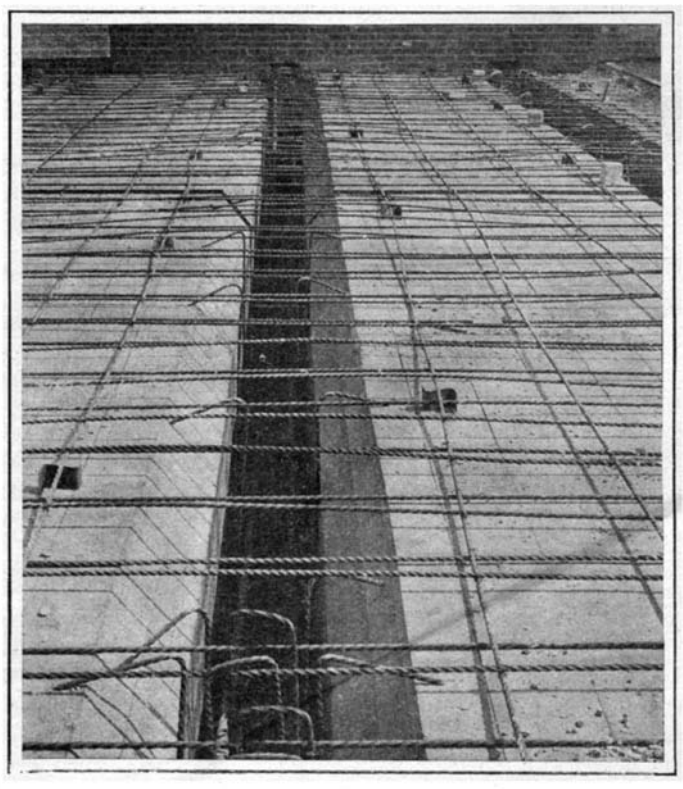


Fig. 8.—Wood Centering and Ransome Steel Bars for 50-foot Floor Span.

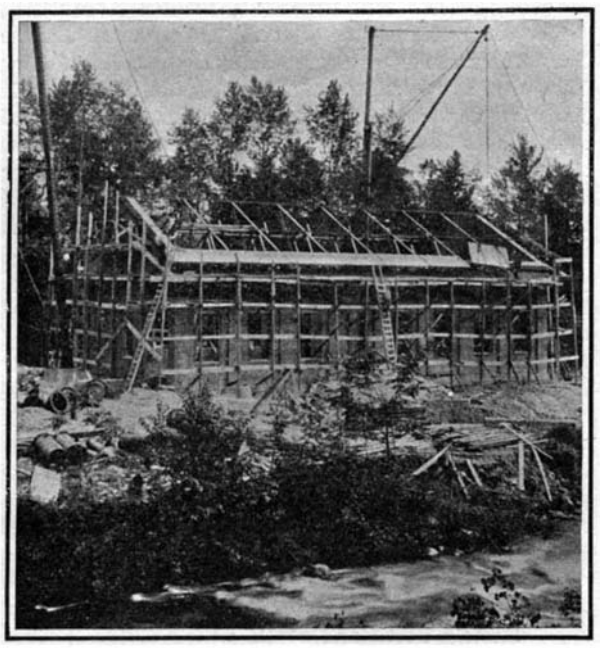


Fig. 9.—Concrete Power Plant in Course of Construction.

concrete. Clinton fabric consists of drawn wire of 6 to 10 gage, which may be made in lengths up to 300 feet. The system is therefore a continuous bond system, which prevents the entire collapse of a span unless the weight imposed is sufficient to break all the wires.

COLUMNS AND PILES.—Reinforced concrete columns are made with either square, rectangular, or circular sections. They are reinforced with from four to twenty rods, the diameters of which vary from ⅝ to 2½ inches. The rods are placed as nearly as practicable to the circumference of the column, so as to give the greatest radius of gyration for the section; but they are never placed so near the surface that they have not at least one or two inches protective covering. The steel so disposed is able to take up the tensile stresses which may be induced in the column by eccentric loading, lateral shock, wind pressure, and the pull of belting.

Columns and piles are made in wooden boxes, each consisting of three permanent sides and a fourth side which is temporary and removable. Under the patent rights of François Hennebique the reinforcing is placed in these boxes, and adjusted by gages to within one or two inches of the sides. The concrete is laid and rammed, about six inches at a time, with small hand rammers. The open side of the box is built up by battens fitting into grooves in the permanent sides, as the work proceeds; this enables inspection of the work to be made, and facilitates the placing of the ties at the proper positions. The ties are made of round wire 3-16 inch diameter and are dropped down over the top of the steel rods. They are spaced from two-inch centers at the bottom and top, to twelve-inch centers in the center of length of the column, and are intended to prevent the steel rods from spreading out under the action of longitudinal loads. Fig. 4 shows the method of joining columns to the floor.

In the Ransome columns as exemplified in a recently constructed factory building (Fig. 7) the vertical reinforcement consists of round rods with the connections made about 12 inches above the floor line. In order that these rods might be continuous the ends were threaded and connected with sleeve nuts, thereby developing the full strength of the rods. Horizontal reinforcement was also used, consisting of hoops formed by a spiral made from ¼-inch diameter soft wire, having a pitch or spacing of 4 inches in the basement columns, and gradually increasing to a pitch of 6 inches in the top story (Fig. 12).

According to Mr. Henry Longcope the first innovation in concrete piles was the sand pile, produced by driving a wooden form in the ground and withdrawing it, the hole being filled with moist sand well rammed. The next method adopted was to drive a metal form into the ground and after withdrawal to fill the hole with concrete. This was not successful, as it was open to the serious objection that on withdrawing the form, the ground would collapse before the concrete could be inserted. Still another method was introduced, which consisted in dropping a cone-shaped five-ton weight a number of times from a considerable height, in order to form a hole, which was afterward filled with concrete. This method never passed the experimental stage. Coming to more successful systems we may mention a method of molding a pile of concrete, allowing it to stand, and then driving it into the ground, a cap being used to protect the head.

Of modern systems which have proven successful Gilbreth's pile must first be recorded. Gilbreth uses a molded corrugated taper pile, cast with a core hole the entire length of the pile, which is jetted down by a water jet and finally settled by hammer blows.

Features which recommend the Gilbreth piles are the opportunities for complete inspection before driving and the fact that they save time because they can be cast while excavation is going on. After being driven they can be loaded immediately. Naturally they present considerable skin friction. The making of these piles above the ground surface also does away with the possibility of their being damaged or squeezed out of shape by the jar occasioned by driving forms for adjoining piles.

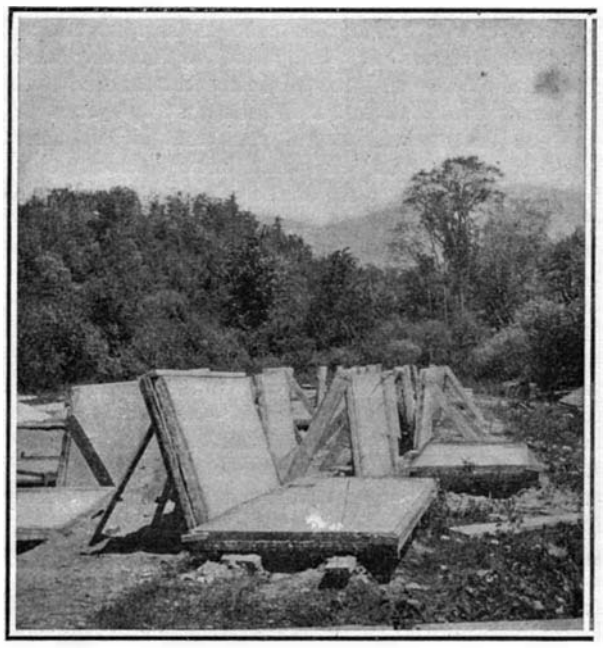
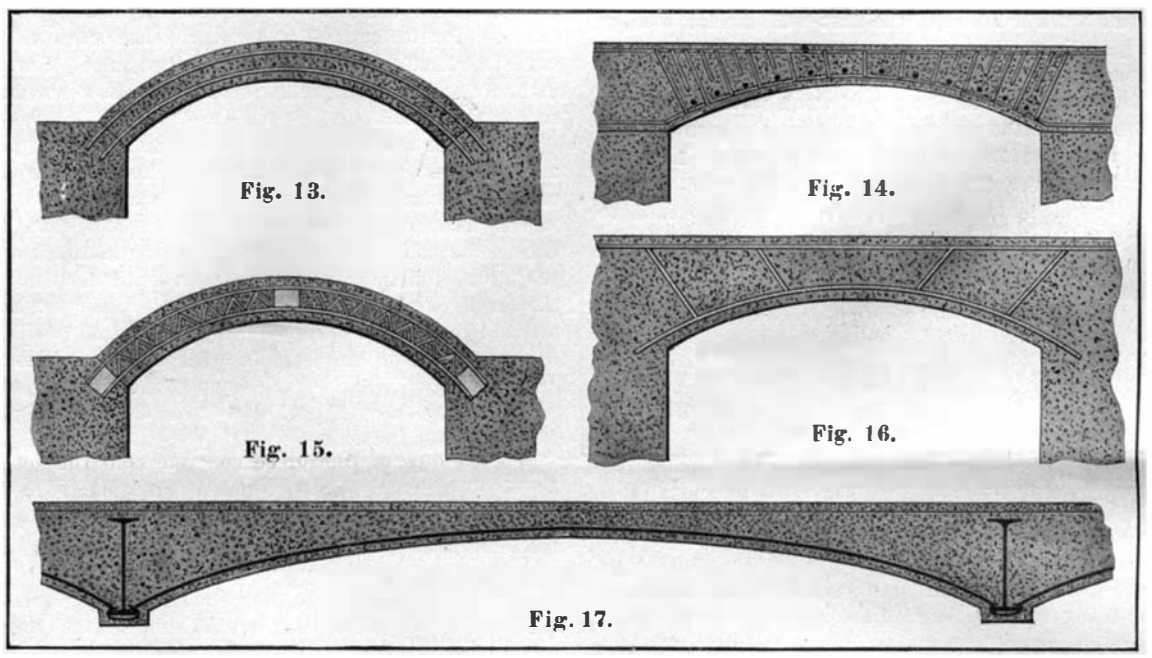


Fig. 10.—Slabs of Concrete Ready for Roof.



Types of Reinforced Concrete Arches.

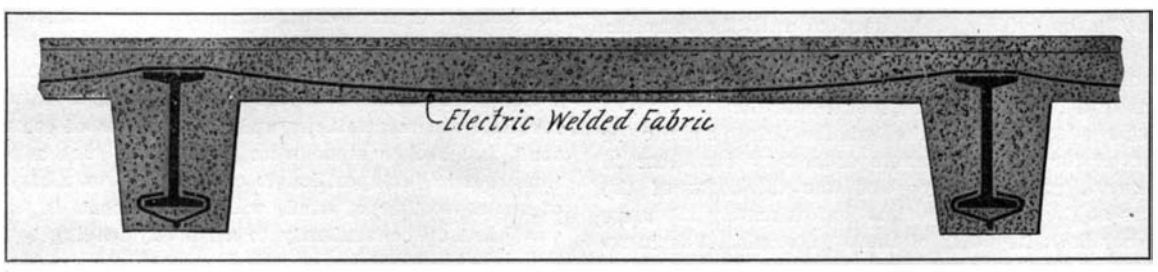


Fig. 11.—Clinton System Using Electrically Welded Fabric.

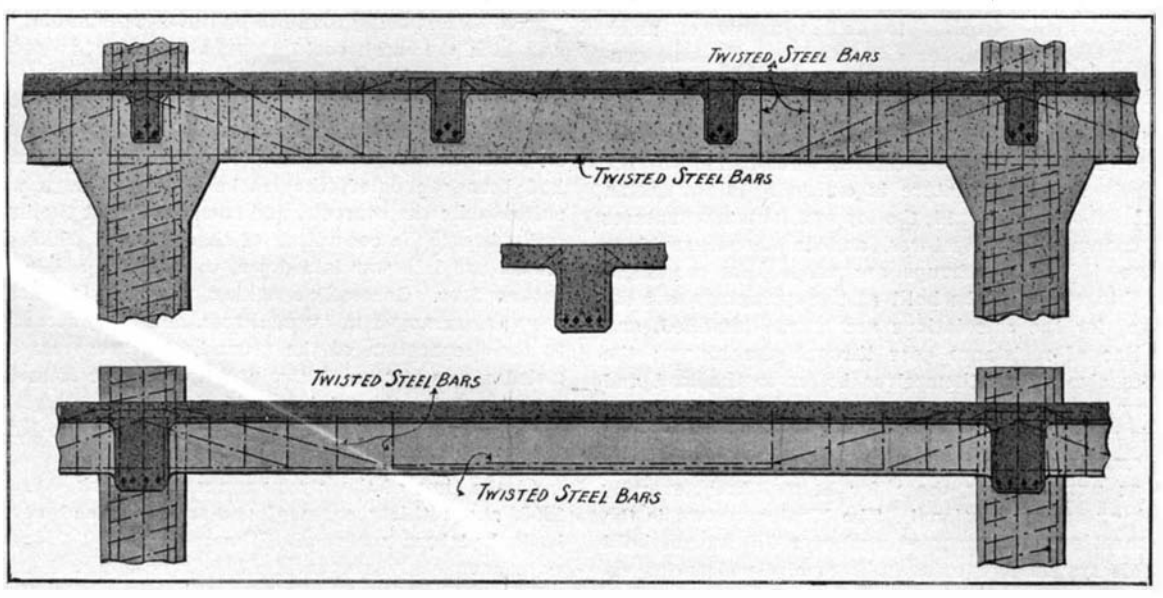


Fig. 12.—Ransome Floor System With Beams.

TYPICAL SYSTEMS OF REINFORCED CONCRETE CONSTRUCTION.

Still another method is used by Raymond. Under this system piles are usually put in by either of two methods, the jetting method or the pile core method. The water jet system is used only where the material penetrated is sand, quicksand, or soft material that will dissolve and flow up inside the pile when the water is forced through the pipe, thus causing the shell to settle until it comes in contact with the next shell, and so on until the desired depth has been reached. The shells are filled with concrete simultaneously with the sinking process, and when necessary spreaders are attached to keep the hole in perfect line with the pipe. The ½-inch pipe is left in the center of the pile and gives it greatly increased lateral strength. If desired, the lateral strength may be further increased by inserting rods near the outer surface of the concrete. By this method, piles of any size up to two feet in diameter at the bottom and four feet at the top can be put through any depth of water and to a suitable penetration in sand or silt (water sediment).

The pile-core method is the one most generally used for foundation work and consists of a collapsible steel pile core, conical in shape, which is incased in a thin, tight-fitting metal shell. The core and shell are driven into the ground by means of a pile driver. The core is so constructed that when the desired depth has been reached it is collapsed and loses contact with the shell, so that it can be easily withdrawn, leaving the shell or casing in the ground, to act as a mold or form for the concrete. When the form is withdrawn, the shell or casing is filled with carefully mixed Portland cement concrete, which is thoroughly tamped during the filling process.

The simplex system uses another method in which the driving form consists of a strong steel tube, the lower end of which is fitted with powerful tooth jaws, which close together tightly, with a point capable of penetrating the soil when driven and also capable of

opening automatically to the full diameter of the tube while being withdrawn. The point of the form closely resembles the jaws of an alligator. At the same time the form is being withdrawn, the concrete is deposited.

It is so evident that concrete is vastly superior to wood in the construction of piles that it is almost superfluous to mention the points of superiority. Concrete is not subject to rot or the ravages of the teredo worm, neither can the piles constructed of concrete be destroyed by fire, and no cost is attached for repairs. While it is not possible to give accurate statistics as to the life of a wooden pile, as it varies so much under different conditions, yet we know that in some cases a wooden pile is rendered worthless in a very few years, especially when the surrounding material is composed of rotted vegetation, or where the pile is exposed by the rise and fall of tides. It is also impossible to state the exact cost of a concrete pile, as it varies also according to conditions. Ordinarily speaking, a concrete pile will cost from one and one-half times to two times as much as a wooden pile; but in order to illustrate where a saving can be made, the following extract is given from a report on the piles driven at the United States Naval Academy at Annapolis, Md.:

"The original plans called for 3,200 wooden piles cut off below low water with a capping of concrete. To get down to the low water level required sheet piling, shoring and pumping, and the excavating of nearly 5,000 cubic yards of earth. By substituting concrete piles, the work was reduced to driving 850 concrete piles, excavating 1,000 cubic yards of earth and placing of 1,000 cubic yards of concrete."

In the work mentioned, the first estimate for wooden piles placed the cost at $9.50 each, while the estimate for concrete piles was placed afterward at $20 each, yet the estimate based on the use of wood piles aggregated $52,840, while the estimate based on the use of concrete piles was $25,403, or a total saving in favor of concrete of over $27,000.

In several instances piles have been uncovered to their full depth, and they were found to be perfectly sound in every particular. By surrounding the operation with the safeguards provided, it is almost impossible to make a faulty pile. The concrete is made as wet as good practice will allow. Constant ramming and dropping the concrete from a considerable height tend to the assurance of a solid mass, then the target on the ramming line or the introduction of an electric light into the form shows what is being done at the bottom of the form.

Floors, Slabs and Roofs.—The system of construction for floors, slabs, and roofs is determined by the extent of the work and the nature of the loads to be carried. If intended for small buildings and offices, the items can be made before erection (Figs. 9 and 10); but in the case of warehouses, factories, piers, and jetties, where live loads and vibratory stresses have to be borne, a monolithic structure is secured by building in molds directly on the site. For the lighter classes of monolithic structure, expanded metal is admirably suitable; it is also much used for the roofs of reservoirs, and for thin partition walls. The meshing is simply laid over the ribs or floor beams, which have been already erected, and the green concrete is applied to the required thickness, being supported from below by suitable supporting work, which is removed as soon as the concrete has set. In cold storage factories, the floor beams and ceilings are invariably erected first, the floor being laid afterward. The ceiling is then solid with the floor beams on their under side, and the floor is solid with them on their upper side, the air space between being a great aid to the maintenance of a low temperature for refrigeration.

In the Monier floors the reinforcement consists of round rods varying from ¼ inch to ⅝ inch diameter. The rods are spaced at about six times their diameter, and are crossed at right angles, being connected by iron wire bound round them. This artificial method of securing the rods takes considerable time, and is thus a somewhat costly process. To produce continuity of metal, the different lengths of rods are overlapped for about 8 to 16 inches, and bound with wire.

The Schlüter are similar to the Monier floors, but the rods are crossed diagonally, and the longitudinal rods are of the same size as the transverse ones. The Cottancin floors have their rods interlaced like the canes of a chair seat or a basket, and the Hyatt floors have square rods with holes through which small transverse rods pass. Over fifty systems of reinforcing are in use, and in most cases the only points of difference are the shape of the section and the method of attachment and adjustment.

Beams.—It is obvious that, as the span increases, a limit will soon be reached beyond which it is not economical to use plain floor slabs, for their dead weight becomes of such magnitude as to prohibit their use. We have thus to resort to a division of the main span by cross beams resting on columns, and the floor is laid on these beams, which are arranged to take as much of the load as to render it possible to reduce the thickness of the floor within reasonable limits. Reinforced concrete beams are typical of the type of construction in which the merits of two component materials are made to serve a common end; but in the particular case of steel and concrete, the actual part played by the steel is not at all well understood.

Speaking generally, beams do not differ in constructional details from floors. The same reinforcement is used in both, the only difference being, that as beams are usually deeper than floors, the shearing stresses become more pronounced, and greater provision has to be made for them by a liberal use of stirrups or vertical binding rods. In some systems the reinforcement consists entirely of straight rods, disposed in any part of the beam where tensile stresses are likely to be called into play. In others, specially bent rods are joined or welded to straight rods, and when welding has to be done it would appear that wrought iron is more suitable than steel.

It is usual to arrange the dimensions of the beams so that the whole of the compressive stresses are taken by that portion of the concrete on one side of the neutral axis; but in some cases, as with continuous beams or heavy beams of small depth, a proportion of the reinforcement is distributed along the compressed portion of the beam, the steel rods either taking up the excess of compressive stress over that at which the concrete can be safely worked, or else taking up the tensile stresses at the places where they occur over the supports. As a general rule we may take it that the economical depth for a reinforced concrete beam, freely supported at both ends, is one-twentieth the span, and is thus approximately the same as that of a steel girder of equal strength. Reinforced concrete beams are now made for spans up to 100 feet for buildings, and 150 feet for bridges. But for each class of work beyond this limit, the weight becomes excessive. Several arched ribs for much greater spans have, however, been successfully built.

The beams are made in much the same way as piles and columns; they can be made in sheds on the site, or in the actual position they are to occupy when finished. The ceiling and beams are erected first, the floor being afterward worked on the top of the beams. We thus obtain a very perfect monolithic structure in which any vibration set up by machinery, falling loads, etc., will be of much less extent than with an ordinary type of building, in which there is often a great want of rigidity, the beams and arches being loosely connected and able to vibrate independently of other parts of the structure.

Concrete being as weak in shear as in tension, provision is also required to take the shearing stresses. Some American designers have to this end patented special forms of reinforcement bar, in which each main tension bar has projecting upward from it ties inclined at an angle of 45 deg. (Kahn system). These extend to the top of the bar and take the tensile stresses arising from the shear. The corresponding compressive stress at right angles to this is carried by the concrete. The system is efficient, and on large spans, where weight must be reduced to a minimum, it has its advantages.

Thus in the Ransome system (Fig. 12) the shearing stresses at the ends of a beam are taken up by inclined reinforcing rods imbedded in the concrete at the junction of beam with column.

Arches.—Concrete has long had an extensive application in the building of arches, but until the introduction of reinforced concrete the arches that could be economically and safely constructed were limited to spans of a few feet. The general rule that the line of resistance fell within the middle third had to be observed for simple concrete arches, as for those in brickwork and masonry; and the thickness of the arches at the crown was thus approximately the same whether built in either of these materials. The introduction of steel reinforcement, however, made it possible not only to reduce the thickness of the ring for a given load-carrying capacity, but by suitably providing for the tensile stresses to enable arches of much greater span and smaller rise to be built. Some general types of arches in reinforced concrete are shown in Figs. 13, 14, 15, and 16. Fig. 13 shows an ordinary arch with top and bottom armature. In many cases where the tensile stresses can safely be carried by the concrete the top armature is omitted. In the Melan arches, shown in Fig. 14, the top and bottom armatures are connected by ligatures, and in the Hennebique arches (Fig. 15) stirrups are used. As a general rule, hinges should be built at the springings and the crown, for the calculations are much simplified, and the line of resistance goes through the hinges; the arches also adjust themselves better to the load and to any slow temperature changes, and when the centering is struck the arch can better take its bearings without cracking. The methods of calculation for arches are as numerous as those for beams, and generally speaking are as irrational. The Monier system is the one most generally adopted, and over 400 bridges built on this system now exist in Europe. In America expanded metal and Clinton electrically-welded fabric are often used. An example of the latter construction will be found in Fig. 17.

CONCRETING THE JEROME PARK RESERVOIR.

The concreting of the westerly basin of the Jerome Park Reservoir, lying near the northerly limits of New York city, is, we believe, considerably the largest single job of concrete paving as yet undertaken. The total area of floor and side slopes of the basin is 101.25 acres, and the whole of this surface was coated with a layer of concrete, which varied in thickness from 6 inches on the floor to a maximum of 30 inches at the top of the slopes.

The figures of quantities involved are very striking. The work called for the use of 625 carloads, or 94,000 barrels, of Portland cement, 1,250 carloads of sand, and 3,125 carloads of crushed rock—a total of 5,000 carloads in all, which had to be hauled into the basin, distributed, mixed, and carefully laid in place. The task is further magnified by the fact that the preparatory leveling down and grading of the floor and slopes involved the taking out of the basin of another 5,000 carloads of excavated material.

The Jerome Park Reservoir was designed to act as a local storage and distributing reservoir within the city limits. It is divided by a central wall running approximately north and south, which divides it into a west basin (completed last year, and now in use with a maximum full capacity of 773,400,000 gallons) and an east basin, which is about 8/10 excavated and when completed will have a capacity of 1,130,000,000 gallons, or a total capacity of 1,903,400,000 gallons. The reservoir is supplied by the old and the new aqueducts, both of which lead from the great Croton Reservoir. At the northerly end of the basin is a large gatehouse, No. 7, through which the water can be discharged into either basin of the reservoir; or, if preferred, it may be taken through the conduits, which are built with the divisional wall, to the central gatehouse, No. 5, where the water can be let into either basin, or sent through the 48-inch pipe lines laid on the floor of the reservoirs (of a pair of which we present an engraving), across the reservoirs to gatehouses Nos. 2 and 3, on the westerly margin of the reservoir, or to gatehouse No. 4, on the easterly margin. From these gatehouses the water may be fed to the city mains, or returned into the basins for the better circulation of the reservoir. From gatehouse No. 4 a 48-inch pipe connects to supply the Jerome Avenue high-service station, or, if desired, the water can be passed on from central gatehouse, No. 5, south through one of two 11-foot circular conduits built in the division wall, to be discharged at the southerly end of either of the reservoirs for the purpose of thorough circulation.

The water received through the old aqueduct can be let into either basin at the northerly gatehouse, No. 7, or it may pass south through the division wall around gatehouse No. 5; or it can be diverted into this gatehouse and into the pipe lines or the reservoir basins.

It is evident that in carrying through a job of concreting on this great scale, the question of its cost was very largely dependent upon the judgment shown in disposing of the large force of labor and the enormous amount of raw material to the best working advantage. A gap was left in the central dividing wall of the reservoir, through which was laid a broad-gage track for hauling in the material. Speaking generally, the plan of operation was to lay approximately parallel tracks, north and south, as they were needed, spacing them 200 feet apart. Each track became a center from which the concreting was carried out on either side for a distance of 75 feet. Scattered along the tracks at distances which were found to be the most advantageous, were fourteen concrete mixers, and the supplies of cement, sand, and broken stone were hauled into such a position, that in juxtaposition to each mixer was a carload of stone, another of sand, while the cement, in bags, was piled up conveniently to a runway leading to the hopper of the mixer.

The concreting was laid in alternate strips about 12½ feet wide, extending 75 feet at right angles to the tracks, 75 feet being found to be the maximum distance at which the work could be economically done. The strips were laid with approximately 12½ foot spaces between them, and after the first strips laid had become hard or set, the intervening spaces were also concreted. As soon as the whole area controlled by one track had been completed, the tracks after ten days were shifted onto the concrete, and commencing at the inner end thereof, the concreting of the space on which the tracks had lain was laid down, thus giving a fair, unbroken floor. Generally speaking, the batteries of mixers were arranged in twos, threes, and fives, according to the preparation of the ground. The concrete consisted of one of cement, two of sand, and five of broken stone, and for the mixing of it there were altogether fourteen mixers employed on the bottom of the basin, and two on the northerly slope.

At the time of the commencement of work, April 1, 1905, about thirty acres of the southerly end of the basin had been concreted. The remaining 71.25 acres were completed between April 1 and October 1, 1905, by a maximum force of 1,200 men; and this in spite of the fact that one month's time was lost through a strike.

During the progress of the work special consideration had to be given to some seven acres of swamp which was encountered. The underlying material of the swamp was a plastic clay. The method of treatment was to excavate all the loose top soil, and lay a grillage or foundation of paving stones, of a size which one man could lift, loose or small stony material being filled into the spaces and compacted. The concreting was laid directly on this paving; and the method adopted was so successful that when the concrete was dry a 50-ton locomotive was run over the surface without any detriment.

The filling of the reservoir commenced on October 26, and water was allowed to pass in slowly until the concrete floor and saddles over the pipe lines were covered for the winter. On March 13, there having been prior to this date a shortage of storage in the watershed reservoirs of the Croton, the water was allowed to pass freely into the basin until it had reached a level of 128.45 feet, which occurred on April 3. On April 9, after drawing 40 million gallons to replenish the depleted storage in Central Park reservoirs, the gates were closed, with the water standing at elevation 127.09 feet, which corresponds to 21.09 feet depth of water. On April 30, with an evaporation, etc., of about 0.017 of a foot per day, the reservoir stood at 127.08, thereby showing that the rainfall directly into the basin itself during these three weeks had about equaled the evaporation. The rainfall during this period was about 5 inches, and the evaporation, etc., about 4½ inches, which shows that the basin, considering the fact that it is new and has had but little time for silting action to take place, is a comparatively tight structure. Moreover, it is significant that in a few places, where water was observed seeping through the masonry when the water was first let in, the chemical action going on in the cement, and the silting effect of the water itself, are gradually sealing up even such slight leaks.

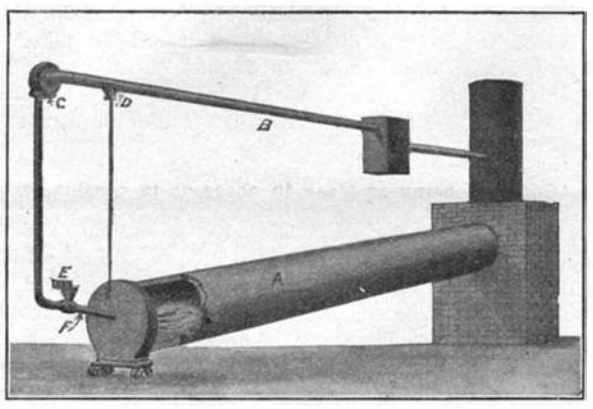
How to Make Concrete.

In determining the proportions of the aggregates and cement for a certain piece of work, it is necessary usually to take samples of the broken stone (or gravel) and sand which are most available to the site, and make measurements of the percentage of voids in the stone which must be filled by the sand, and the percentage of voids in the sand which must be filled by the cement. This is done by taking a cubic-foot box and filling it with broken stone in a thoroughly wet state. The box is then filled with as much water as is required to completely fill it in addition to the stone, which upon being poured off gives the relation between the volume of the voids and the volume of the stone. The required amount of local sand thus determined is then measured out and placed in the box with the stone in a damp state. Water is then used to determine the percentage of voids left in the sand, which gives the approximate amount of cement required, although an excess of cement is almost invariably used. Engineers everywhere differ regarding the best proportion to be used, but in general the above test, roughly made, will determine it well enough. The proportions which are most universally used are as follows: 1 cement, 2 sand, 4 broken stone; where extremely strong work is desired. Tests show that a 6-inch thickness of 1—2—4 concrete properly made is waterproof up to about 50 pounds to the square inch. This concrete is frequently used for facing dams. 1—3—6 is the proportion generally used for the interior of dams and large structures. It is entirely suitable for large foundations. 1—4—8 is frequently used for foundation work, and when properly mixed makes good concrete, although it is about the limit of what is considered good work, and would not be suitable for very important structures. 1—5—10 is equal to any concrete made with natural cement. It is a well-known fact that the volume of concrete when mixed with water is somewhat less than the volume of the aggregates and cement before mixing. The contractors' rule is that the volume of mixed concrete is equal to the volume of the stone plus one-half to one-third the volume of the sand.

There has been much discussion among engineers and others as to the amount of water that should be added to the aggregates and cement for making the best concrete; and while it is not the purpose of this paper to enter into this controversy, it might be said that the modern tendency is toward wet concrete. The old way was to add just enough water, so that when all the concrete was in the form and tamped, it would show moisture on the surface. The tamping is a very important part of the operation, and the quality of the work is dependent upon how well this is superintended, as unless it is well and thoroughly done the concrete is liable to be honeycombed and imperfect, especially near the forms. With the growth of the use of concrete the old method of putting it in the forms nearly dry and depending on tamping to consolidate it has been more or less abandoned, and the more modern way is to put the concrete in quite wet, as less tamping is required and much labor and expense saved. One of the great objections to this scheme is that if care is not taken, the water will tend to wash the cement from the stone and sand; in other words, unmix it. However, it may be said that it is now generally understood that rather wet concrete properly handled makes better work. The amount of water to be added to the aggregates and cement varies from 1 water to 3 cement by measurement to 12 per cent of water by weight. In 1887 Mr. Carey, of Newhaven, England, made the statement that 23 gallons water per cubic yard of cement was the best mixture. Quite frequently salt water is used in mixing concrete in cold weather to prevent freezing, and it seems to have no ill effects on the resulting mixture.—Cement Age.

THE IMPINGING FLAME IN CEMENT BURNING.

The use of the impinging flame in cement burning has come to be recognized as the best method yet devised for increase of output and economy of fuel. This principle, as put into practice under patents granted to Mr. Byron E. Eldred, has attracted the attention of cement manufacturers all over the country. In the Eldred process the air used to support combustion is modified by mixing with it a certain amount of waste stack gases of the kiln. The method of operation is shown clearly in the accompanying diagram. The waste gases are conducted through the pipe, *B*, by the exhaust fan, *C*. Air is then admitted at the opening, *D*, the amount of oxygen desired in the mixture being accurately controlled by means of dampers. The fan, *C*, discharges this mixture into the coal feeding apparatus, *E*, from which it goes through the pipe, *F*, into the kiln, *A*. The point, *F*, is so arranged with reference to the kiln that the hottest part of the tempered flame comes into direct contact with the material. One striking advantage of the process is the easy regulation of the mixture made possible by the manipulation of the damper at the air inlet, *D*. It is possible speedily to adjust the air mixture to meet conditions in the kiln; thus, when rings begin to form, an increase in the quantity of stack gases can



THE IMPINGING FLAME IN CEMENT BURNING.

be quickly made, which causes the removal of the mass. An experienced operator will have no difficulty with the Eldred method in obtaining a direct impingement of the flame and at the same time avoiding difficulties which formerly arose due to contamination of the discharging clinker. In using this process the cement company has been able to increase the output of each of its eight kilns about eight per cent, and to make a saving of about five per cent in consumption of fuel without causing any change in the quality of its product.

Official Meteorological Summary, New York, N. Y., April, 1906.

Atmospheric pressure: Highest, 30.47; date, 3d; lowest, 29.44; date, 25th; mean, 29.98. Temperature: Highest, 74; date, 30th; lowest, 31; date, 1st; mean of warmest day, 64; date, 30th; coldest day, 40; date, 1st, 2d; mean of maximum for the month, 60.1; mean of minimum, 43.3; absolute mean, 51.7; normal, 48.7; average daily excess compared with mean of 36 years, +3.0. Warmest mean temperature for April, 54, in 1871; coldest mean, 41, in 1874. Absolute maximum and minimum for this month for 36 years, 90, and 20. Precipitation: 5.78; greatest in 24 hours, 2.42; date, 9th, 10th; average for this month for 36 years, 3.35; excess, +2.43; greatest precipitation, 7.02, in 1874; least, 1.00, in 1881. Snow: Trace; date, 9th, 23d. Wind: Prevailing direction, northwest; total movement, 9,712 miles; average hourly velocity, 13.5 miles; maximum velocity, 54 miles per hour. Weather: Clear days, 12; partly cloudy, 11; cloudy, 7. Thunderstorms, date, 21st, 30th.

The Current Supplement.

The current SUPPLEMENT, No. 1584, is opened by B. S. Bowdish with an article on the Rapid Growth of Birds. An article on Artificial Gems will be of interest to the jeweler. Mr. James P. Maginnis continues his discussion of Reservoir, Fountain, and Stylographic Pens. A fourth installment of Valuable Alloys is published. Interesting to the naturalist is an article on the domestic life of animals. The well-known meteorologist, Prof. Cleveland Abbé, writes on the relations between climates and crops. A most ingenious piece of mechanism is described in an article entitled "A Speed and Mileage Recorder for Automobiles and Railroads." The Tangent Galvanometer and Its Construction is described.

THE ADVANTAGES AND LIMITATIONS OF REINFORCED CONCRETE.

(*Continued from page* 383.)

with the older materials. This condition must be charged in large measure to the fact that proprietary concerns have been chiefly instrumental in promulgating the use of the new material. Their purpose has not been that of true engineering to adopt the material only for such uses as it is particularly fitted, but that of the sales agent, to dispose of as much material as possible by forcing its use in every conceivable way. The natural result has been to see reinforced concrete used in many places where plain concrete would have served well enough, and in other places where every consideration called for the use of steel. The remedy for this evil will come with the passing of concrete-steel work into the hands of engineers whose only object is to employ the material best fitted for their purpose, be it whatever it may; and this transition has already begun. Another evil rising from the same cause and destined to be remedied in the same way is the tacit acceptance of empiricism as a rule of design. Already the theory of reinforced concrete is engaging the time and attention of many competent engineers, and a mass of reliable test data is being accumulated which will soon relegate empirical rules for reinforced concrete to the position they have long occupied in designing steel structures.

These strictures against empiricism will doubtless meet with opposition from some quarters, but they are entirely warranted. There is no place in engineering for guess-work whenever scientific determination is possible. It is becoming increasingly plain, moreover, that it is possible in reinforced concrete work. The common assumption of certain builders, that the laws, formulas, and methods of calculation used for ordinary materials cannot be applied to such a combination of two materials as is reinforced concrete, comes very close to being utter nonsense. The sooner such assumptions are banished from reinforced concrete work, the better it will be for the engineer and the building public; any attempt to weave a net of mystery about the new material is entirely wrong.

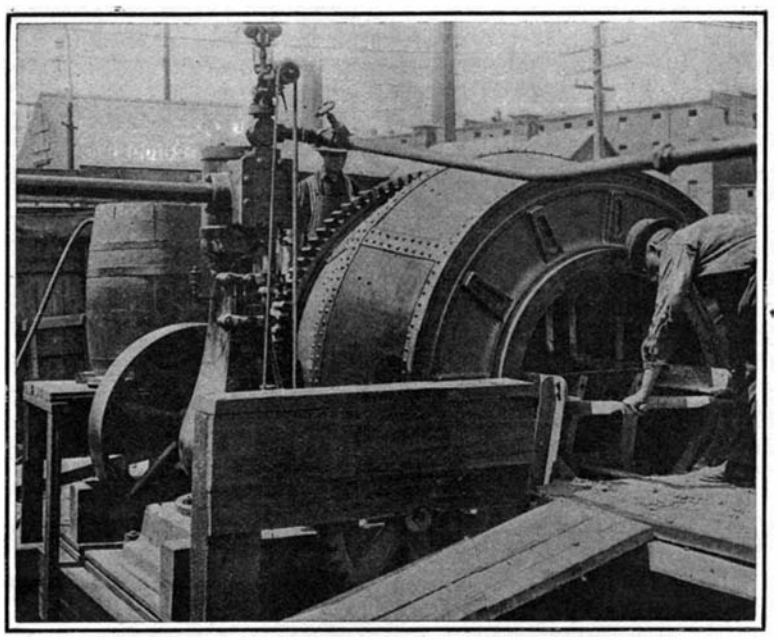
What Science Loses by the Earthquake.

Science has lost almost irretrievably in the destruction of one institution, not to refer to others, in which the most ardent hopes of the future were centered. The history of the California Academy of Sciences has many counterparts in other institutions devoted to pure science. It was begun forty years ago, and after a career of stress and poverty, at last as a beneficiary of the Lick estate, emerged into the full sunshine of wealth, and with splendid equipment was doing invaluable work in investigation and discovery. The latest expedition to be sent out by the institution is even now at work preparing a catalogue of the flora and fauna of the Galapagos Islands, where a company of scientists are exploring that remote group, and filling a gap which thus far has remained a blank page to science. In the department of entomology the academy has done immense service to general knowledge. Its collection of specimens was one of the finest in the world, and can never be replaced, and its museum of natural science, fossils, Indian curiosities, reptiles of California and Lower California, Aztec and Mexican, birds, together with a complete collection of the flora of the Pacific coast, included much that can never be replaced and many things that are lost to the world forever.

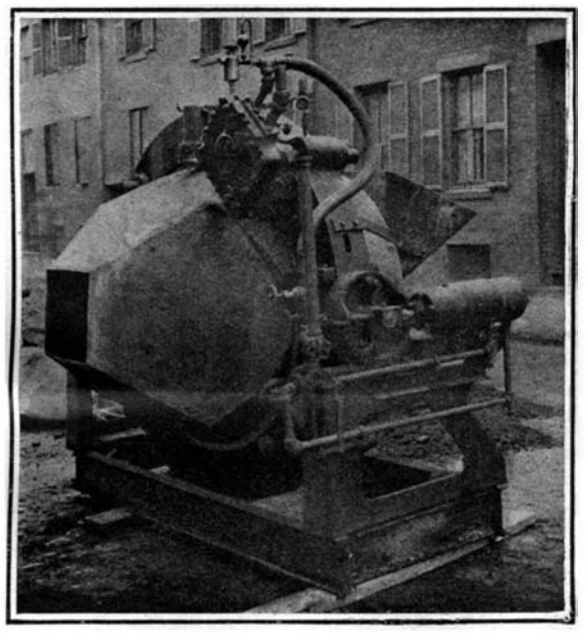
The Astronomical Society of the Pacific lost its valuable records and many rare manuscripts, as did the Geographical Society of the Pacific. The University of California, with its great museum temporarily housed at the Affiliated Colleges, suffered no loss from either shock or flames. Every public library in San Francisco fell a victim to the catastrophe, the largest being the Free Public with three branches containing 150,000 volumes; the Mechanics', with 80,000; the Mercantile, with 60,000; and the San Francisco Law, with 41,000; and the library of the California Historical Society, with its priceless manuscripts and unreplaceable records. There were in the city many noted private and professional libraries, which were all destroyed; no one had time to save books. Millions of volumes were reduced to ashes. Of schools and colleges destroyed, the most noted was St. Ignatius, a college of the Jesuit Fathers, located on Van Ness Avenue and the first established in San Francisco. The society also lost its magnificent church, built in the style of the Spanish Renaissance and richly decorated. College and church cannot be replaced for less than a million and a half dollars. Twenty-eight public schools of all classes were burned.

CONCRETE MIXING MACHINERY.

In the making of concrete, everything depends upon the thorough mixing of the component materials. The proportions of cement, sand, and stone vary, of course, with different conditions; but whatever they may be, it is important that there be enough sand to fill in the interstices between the stones, and that there be enough cement to fill in all the interstices between the grains of sand. Care should, therefore, be taken to coat each grain of sand with a layer of wet cement and each stone with a layer of this mortar. Concrete when properly made is of an even gray color, showing a perfect mixture and uniform coating of the sand and stones. This theoretical perfection of mixing is very closely approximated in large quantities of concrete by the use of special mixing machines. The first machine for performing this class of work was constructed on the lines of the brickmaker's pug mill—that is, the mill used for mixing and breaking up lumps of clay. This is mentioned in Hunt's "Dictionary of Arts, Manufactures, and Mines" of 1875. The next development was the trough mixer, consisting of a trough adapted to receive measured quantities of cement, sand, and aggregates, and a series of paddles adapted to mix the materials in the trough and move them toward the discharging end. Following the trough mixer came the cube mixer, an excellent machine which still survives. It consists of a



Gilbreth Machine Discharging Into a Wheelbarrow.



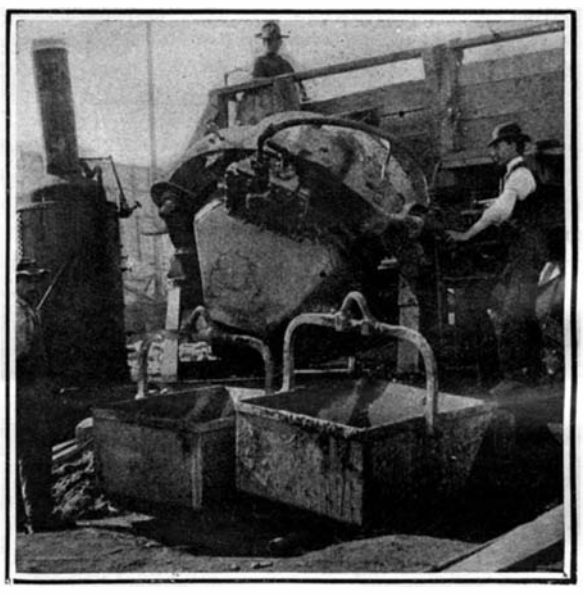
United Concrete-Mixing Machine in Mixing Position.

cubical box of sheet steel with bearings at opposite corners and turning on a horizontal axis. A trap door at one side serves to admit the materials, which are thereupon thoroughly mixed by rotating the box.

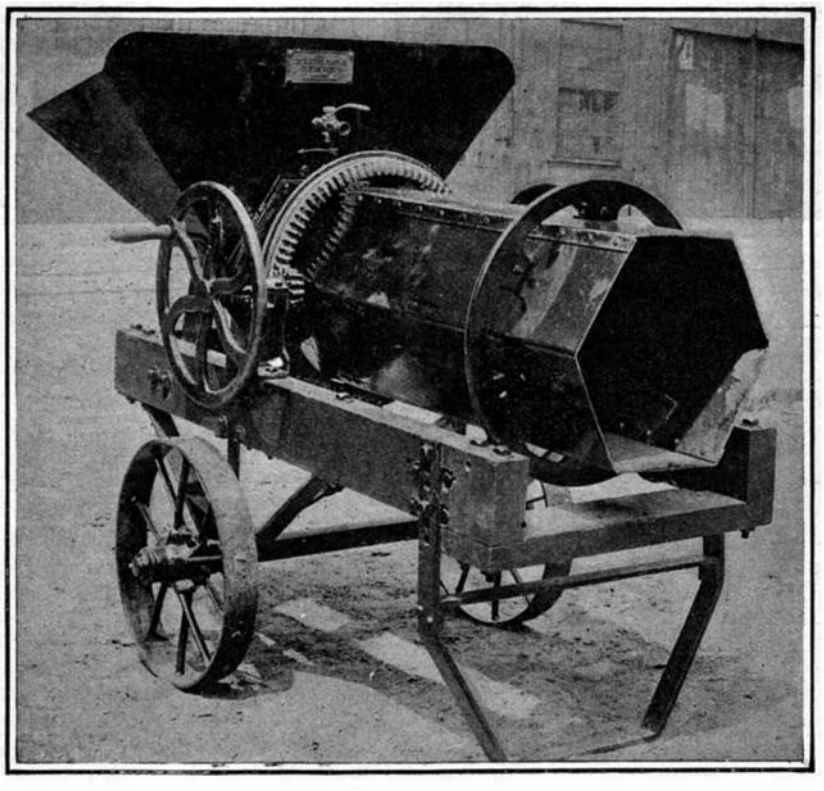
The cube mixer belongs to that class of concrete mixing machines known as "batch" mixers, in which the concrete is made in separate measured quantities or batches, as distinguished from "continuous" mixers, which are continuously discharging mixed concrete at one end while being fed at the other. To the latter class belongs the trough mixer, which is still used to a limited extent. The gravity mixer, also of this class, was invented by Mr. Frank B. Gilbreth some years ago to meet special requirements. Having a concrete foundation to lay, it occurred to him it might be a good idea to set up an inclined chute leading from the street to the bottom of the excavation, and by means of a series of spikes in the chute to effect the mixing of the cement and aggregates shoveled in at the top of the chute. The experiment proved quite satisfactory, and led to the development of the portable gravity mixer, which has been quite extensively used. It is evident that the mixture of materials in a machine of this sort is largely a matter of chance, and for this reason the gravity mixer is most useful for massive foundations and similar large and heavy work in which, owing to the vast proportions of the work, occasional defects in the quality of the concrete can be ignored.

Another of the "continuous" type of mixers is the hand power machine, which is illustrated herewith. It has a long hexagonal body open at one end, and at the other it is fitted over a fixed hopper through which the materials are poured in. The body is geared to be rotated by hand, and contains a series of blades secured to the side walls. The blades are set at an angle with the axis of the mixer, and serve to feed the materials from the hopper to the open end. Mixers of this type are very useful for small work, such as concrete block making.

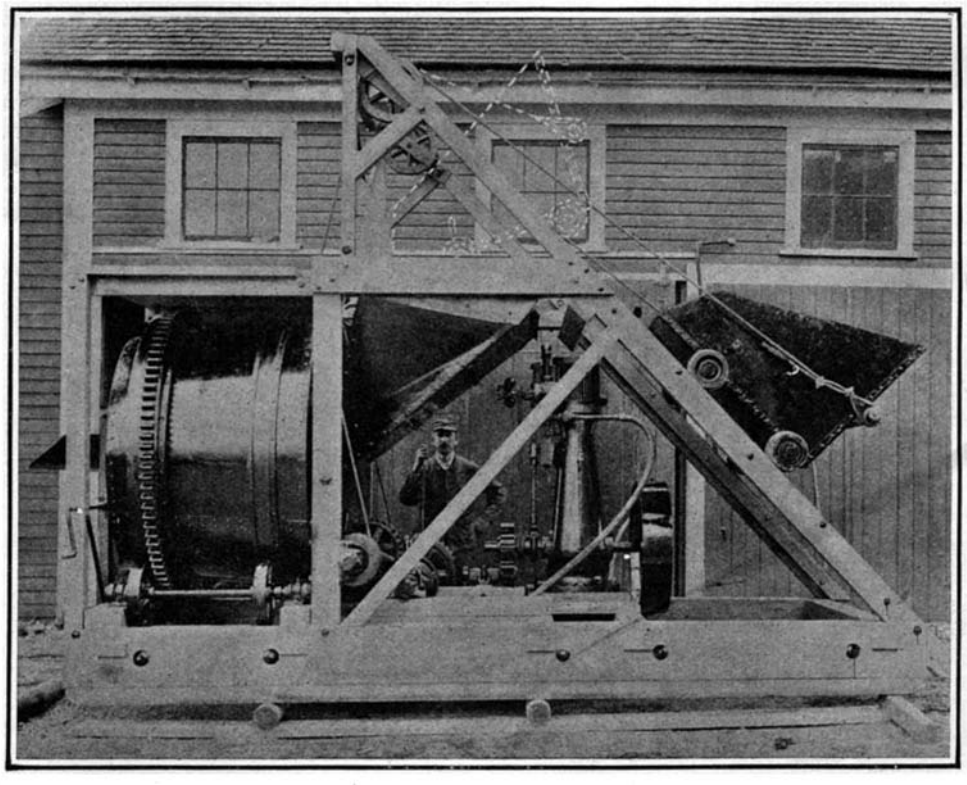
In this country a decided preference is shown for concrete mixers of the "batch" type, and this because it is next to impossible to thoroughly mix materials that are continuously moving forward. Mixing them by batches is a much more logical process, because the materials can be turned over and over and tumbled about until there can be no doubt of an intimate mixing. Many varieties of batch mixers are now in use. The first of these to come into general use comprised a rotary cylinder or drum, provided at one end with an opening to receive the batch and with an opening at the other end to discharge it. An excellent illustration of this type of mixer is to be found in the accompanying engraving of a "Ransome" machine. The illustration shows the drum partly broken away to indicate the peculiar arrangement of the vanes within. The circular wall of the drum is ribbed with a series of narrow steel plates or scoops, which extend diagonally from end to end of the drum, with a sharp upward bend near the front head of the drum. Riveted to each of these scoops near the bend is a blade or slide, which extends at a tangent thereto and its outer end rests on the edge of the next adjacent scoop. The machine reproduces the manual method of mixing the materials, namely, that of lifting them with a shovel and turning them over. Each scoop serves as a shovel, lifting up a portion of the batch, and owing to the diagonal set of the plate causing the material to slide toward the front or discharge end of the machine. Then, as the scoop nears the top of its orbit, it pours out the material onto the slide, which conveys it back to its starting point at the mouth of the drum. A thorough commingling of materials is thus insured. When, in a few moments, the concrete is properly mixed, the attendant operates the lever shown to the right in our illustration, lowering the discharging chute. The inner end of this chute catches the material poured out of the scoops, and conveys it out of the drum to the wheelbarrow, car, or bucket. The great advantage of this form of discharge over that of the "tipping" mixers is that it does not require a high working platform for the machine, because, as the chute is fed from the top of the drum, its lower end will be high enough to clear the wheelbarrow or



United Concrete-Mixing Machine Discharging a Batch of Concrete.



Hand-Power Concrete-Mixing Machine.



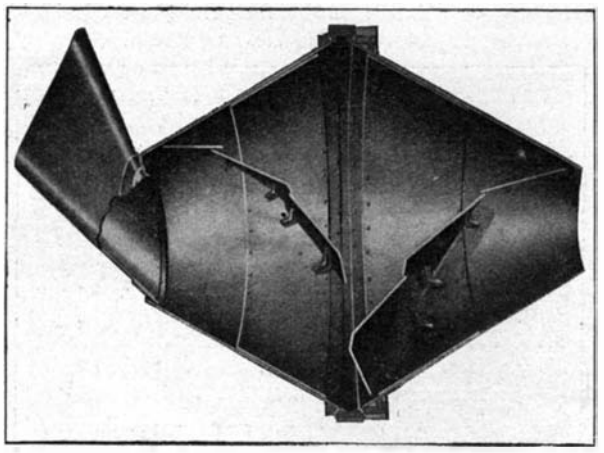
Gotham Mixer Equipped With Loading Mechanism.

CONCRETE MIXING MACHINERY.

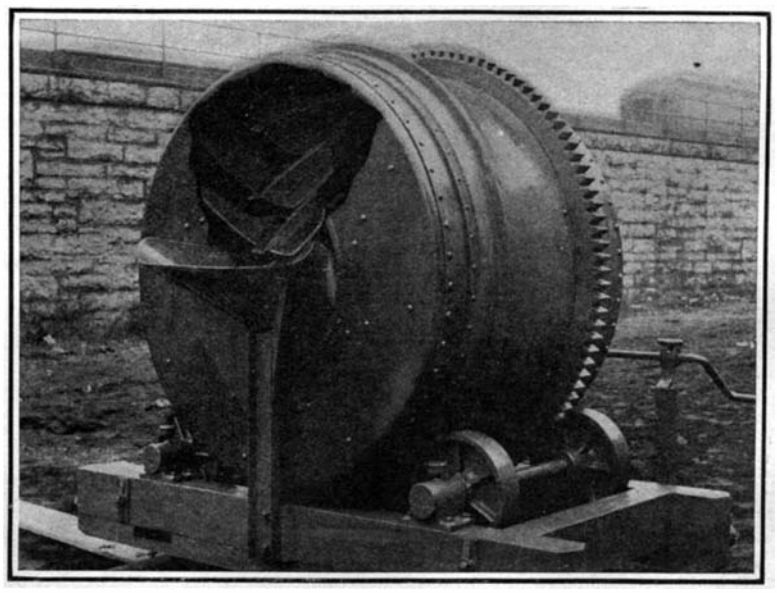
other receptacle used. The drum rotates continuously, both when discharging and when being charged, at a rate of about fifteen revolutions per minute. It turns on four rollers. One of the roller shafts is fitted with a driving pulley, and also with a pinion which meshes with a gear ring on the drum and causes the latter to rotate.

Another interesting concrete mixer of the same type is the "Gilbreth rotary." This machine is unique in that it can be loaded or discharged from either or both ends. The openings in the opposite heads of the drum are large enough to admit a wheelbarrow, as pictured in our illustration. Within the drum is a stationary framework carrying a pair of rails, which serve as guides for the wheelbarrow. This framing also carries a set of "coating tables." The aggregates and the cement are picked up by scoops and cast violently against these stationary coating tables. After proper mixing a wheelbarrow is placed in the machine, and it receives the concrete as it pours out of the scoops. If desired, a chute can be used in place of a wheelbarrow, both for charging and discharging the machine. The "United" mixer, which is shown in two of our engravings, illustrates a different system of discharging the batch. The machine belongs to the "tipping" class, the mixing chamber being so mounted that it can be tipped up to discharge its contents. The mixing chamber is in shape of a drum formed with a large pyramidal chute or spout at its discharge end. The drum is mounted to revolve in a ring, which in turn is designed to rotate on an axis in the same plane as, but at right angles to, that of the drum. Mounted on this ring is an engine of the square piston type, which drives the drum directly by means of spur gearing. Steam is fed to this engine through a flexible tube. This direct system of drive does away with a lot of complicated mechanism, which would be necessary were the machine operated by a stationary engine. Steam power is also used for tipping the drum. As shown in one of our illustrations, the rocking support of a ring frame consists of a pair of mutilated spur gears secured thereto, one at each side, and engaging horizontal racks on the main frame of the machine. Connected by a pitman with the axis of the spur gear is a piston, which works in a steam cylinder on the main frame. The piston has three positions, one for charging, the second for mixing, and the third for discharging. When the piston is moved to its extreme rearward position, it draws the entire ring frame and mixing drum back, causing them to tip back slightly. This lowers the charging chute, so that the materials can be more easily fed into the drum. The intermediate position of the piston carries the drum back to the horizontal, which is maintained until the materials have been properly mixed, when the piston is driven to the extreme forward end of its stroke, tipping the drum down, and permitting its contents to pour out. The machine can, of course, be charged when in its mixing position if conditions permit of hauling the stone and sand to a sufficient height above the drum.

One of the simplest machines of the tipping class is the "Smith" mixer. The mixing chamber of this machine consists of two truncated cones, with their larger ends joined together and their smaller ends open. In one end a chute is fitted, by means of which material is fed into the mixing chamber. Within this chamber are a series of blades which project radially inward. One of our illustrations shows a longitudinal section of a Smith mixer, and indicates the form and position of the blades. It will be observed that they follow the general outline of a spiral screw thread, and are adapted to carry the material from the center of the chamber toward the ends. The thread, however, is not continuous, and as the drum revolves, the material drops through the gaps between the blades, and slides down the inclined conical walls to the center of the chamber. The arrangement of the blades and the conical form of the drum are excellent, not only because they insure a thorough stirring and mixing of the batch, but also because there are no corners or pockets in the mixing chamber which would be liable to be clogged. When the batch is mixed, the drum is tipped up and the materials are poured out. The drum is mounted to turn on rollers in a swinging frame, the latter being journaled to a fixed frame. The driving mechanism comprises a pair of miter gears, one keyed to one of the axles of the swinging frame, and the other carried by the swinging frame. Secured to the shaft on which the latter bevel gear is mounted is a small spur pinion that meshes with the gear ring on the mixing drum. Power is transmitted to the mechanism by a driving pulley. The drum is tipped manually by depressing a lever secured to the axle at the opposite side of the machine.



Section of Smith Machine Showing Spiral Blading.



Ransome Machine Broken Away to Show Arrangement of Scoops.

Intimately connected with the subject of concrete mixers is the question of measuring out the materials, and delivering them to the mixing drum in an economical manner. Too little attention is paid to this question, and the majority of plants will be found to be working under most uneconomical conditions. A small mixer properly equipped with means for measuring out the batches and for expeditiously supplying them to the mixing drum will turn out twice as much work as the large machine operated in the usual wasteful manner. One of our illustrations shows a small plant comprising a "Gotham" mixer, driving engine and charging car. The car travels up a pair of inclined rails to a position above the mixer, where it tips (as indicated by dotted lines in the engraving) and pours its load into the charging chute of the machine. The car is large enough to contain a batch, and is loaded while the previous charge is being mixed. Instead of shoveling stone and sand into a waiting machine, the shoveling is done into the car while the machine is at work, and then dumped into the mixing drum as soon as the latter is emptied without the loss of a moment, thus making both the loading and mixing practically continuous. For very large work a more elaborate equipment is necessary. We illustrate herewith a very complete plant used in laying the concrete foundations of a large gasometer. A tower is built at the edge of the excavation, and at the top of this tower there are two bins, one for stone and the other for sand. The bins are supplied by a belt conveyor, which feeds either stone or sand as desired, a chute being used when filling the sand bin to carry the material past the stone bin. Owing to limits of space at this particular plant, the stone and sand must be dumped in stock piles at a short distance from the conveyor, and then hauled to the conveyor in wheelbarrows. Just below the bins is the measuring platform, on which the measuring hopper is placed. This has a compartment of measured size for sand, and another for stone. Spouts from the bins above lead respectively to these compartments, and to measure out enough stone and sand for a batch, the operator needs but to open the gates of these spouts, letting the materials pour into the measuring hopper until the compartments are filled. Another gate is then opened to permit the measures of sand and stone to slide through a chute into the mixer below, and at the same time the cement and water is poured in. No measure is required for the cement, as it comes in bags of a measured size, and it is merely necessary to throw in one, two, or three bags, as the case may be. Each bag contains one cubic foot of cement, and it serves as a basis among some manufacturers for rating their mixing machines, as the size of the batch, of course, depends upon the quantity of cement used. A "Smith" mixer is used in the plant just described, and as soon as the concrete is thoroughly mixed, the machine is tipped up to pour the material into cars, which are run on tracks to any desired part of the foundation. The entire plant is an excellent example of practical economy with the exception, perhaps, that no convenient storage bin is provided for the cement, and it must be hauled by laborers from the cement shed to the measuring platform.

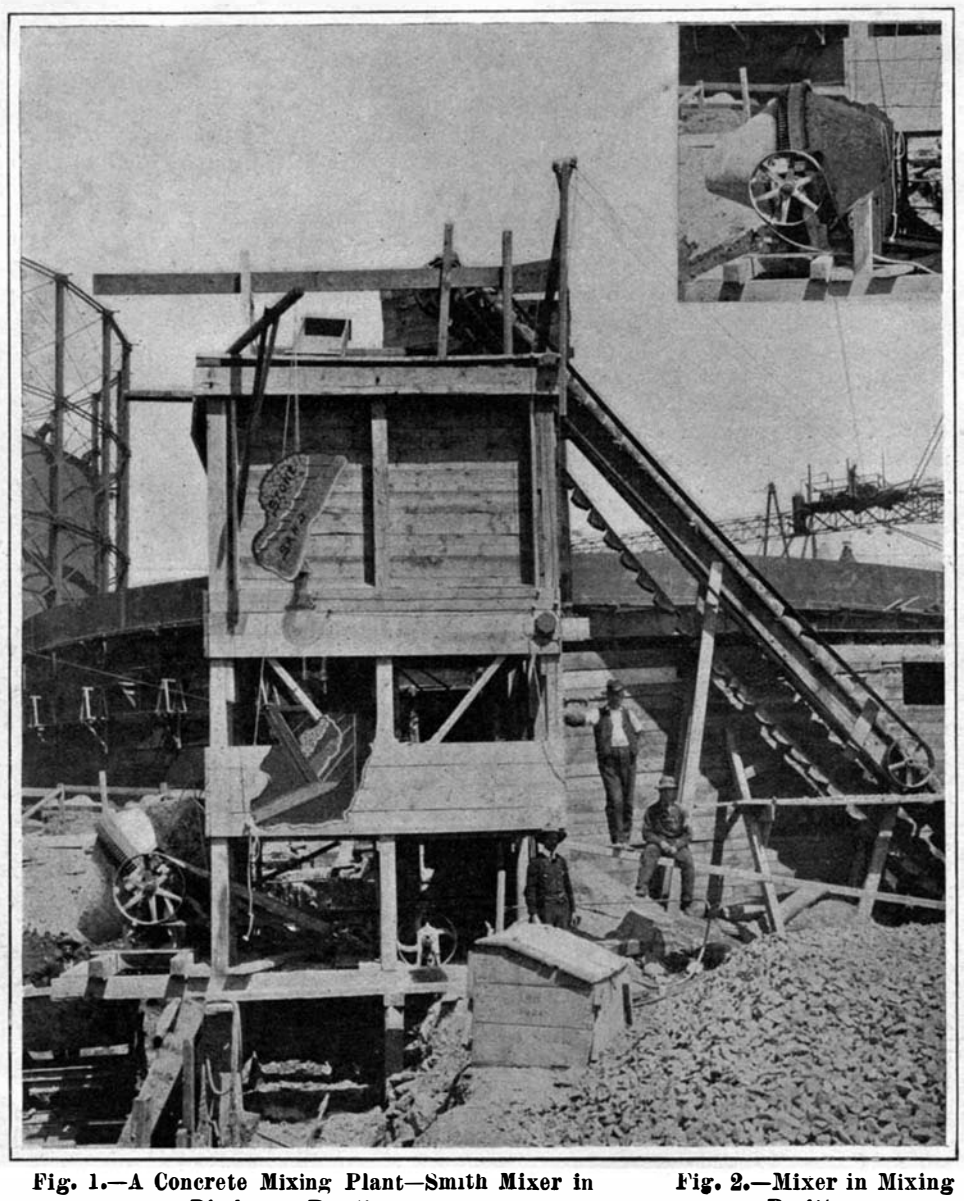


Fig. 1.—A Concrete Mixing Plant—Smith Mixer in Discharge Position.

Fig. 2.—Mixer in Mixing Position.

CONCRETE MIXING MACHINERY.

Linoleum for Cement Floors.

To make linoleum adhere to a cement floor, a glue is used which has been boiled until it is of the consistency of carpenters' glue, and to which sifted wood ashes have been added, stirring, to make a mass resembling varnish. Apply to the lower side of the linoleum, and press hard against the floor.—Die Werkstatt.

CONCRETE BLOCK MACHINES.

The marvelous advance in the manufacture and use of concrete, reinforced and in block form, for residential and business construction has opened a new era to the present-day builder. It has made possible an absolutely fireproof skyscraper and a non-inflammable cottage. It has eliminated the constantly recurring expense incident to painting, shrinking, and cracking of house walls. It has made coal bills less in winter and assured coolness in summer. It has reduced the cost of fire insurance. It has made possible a structure which is a guarantee of its own durability, as concrete improves with age. Rain, frost, and heat and the violent changes of weather, which cause wood to warp and rot and brick to crumble, have no effect on the structure built of concrete. With all these advantages, concrete has the merit of cheapness; and so great has been the demand for its use, that more than a thousand firms and individuals are engaged in its manufacture, and more than three hundred makes of machine turning out concrete blocks are on the market.

These machines cover a wide and increasing field Nor is their use confined to the production of blocks alone. They are employed to turn out shingles, posts, pillars, cornices, and ornamental designs, often of intricate pattern. They vary in capacity from one hundred to two hundred blocks a day with the hand machines to six hundred blocks a day for the power machine working under one hundred tons pressure. In general they may be divided into two classes—the side-face and face-down. It may be put down as a guiding fact for the reader, that any machine with a vertical core is of necessity a side-face, and any machine using a horizontal core, a down-face machine. As we have already stated, the side-face and down-face represent the basic difference between the two types. In various machines of each type the sides of the mold are dropped down by hand or mechanism, leaving

Fig. 3.—Lifting Out the Block.

the product on the bedplate; and in others the product is raised to permit its easy carting away. Each type has its supporters. The side-face machine makers contend that only by their process is a perfect block obtainable, free from settling, and ready to lay in the wall as made. The down-face makers point out that only on their principle is a veneered face possible without leaving a line of cleavage. They also contend that only on a down-face machine can an accurate reproduction of a face design be made. Decision as to the merits of the two processes must be left to the reader. The former style of machine can justly claim the credit of being the first of any kind put on the market, the H. S. Palmer, the N. F. Palmer, and the Normandin being the initial makes which really turned out blocks actually used in putting up buildings. During the past few years there

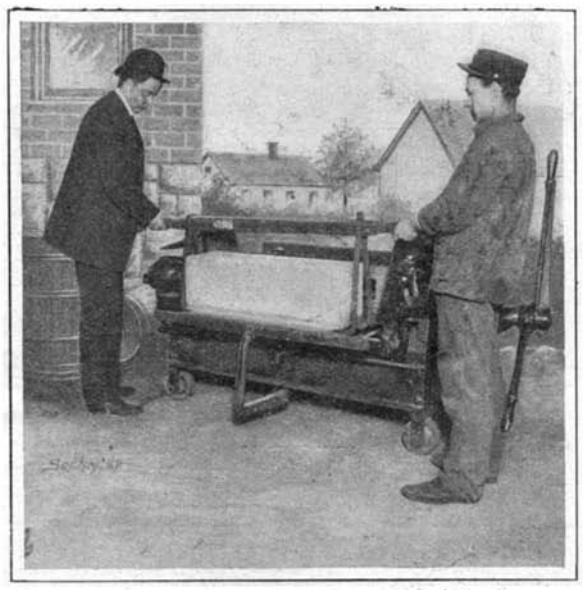


Fig. 1.—Carrying Away a Finished Hayden Block.

have sprung up so many variations of the side-face and down-face machines, that to describe even a small number of them would necessitate a volume. This article aims only to give a general idea of the types as represented by the various makes.

The early forms of block-making machines did not turn out blocks which could be used to build residences. They did make a product available for the erection of small structures, such as poultry houses and farm outbuildings. The simplest form of machine was extremely elementary, consisting of two plain-face sides, two plain ends, a rock-face side and end, a core, and two tampers. This was nothing more than a mold-box, and its crudity gives a fair idea of its limitations. With it two men could turn out one hundred blocks, 8 by 9 by 16 inches, a day, tamping being done on top and the core taken out by hand. Equally simple in construction was the Pettyjohn machine, in which the mechanism was lifted bodily, leaving the block on the pallet. This necessitated the removal of the mechanism from place to place. Still the machine was extensively used at one time throughout the West. Both these mold-boxes were built on the side-face principle.

Having attained some proficiency in turning out the small blocks, manufacturers set to work to evolve a mechanism by which rapidity of output could be combined with durability and change of size of product. The use of the wooden pallet over the iron was an early step to obtain speed, and was first employed by E. W. Seamans, who introduced the small hand machine embodying the wooden pallet. It is true that the blocks lost in form and beauty somewhat, but the gain in time did much to popularize the innovation. A further step in the rapidity of output was obtained by the Dayton machine seen in Fig. 7, capable, with two men tamping, of turning out one hundred and fifty 24 by 9 by 8-inch blocks a day. Here the block lay originally rock face down, and was tamped in that position. By using a spring canter it was then thrown into the position seen in the picture, the pallet board being held in place until the product was ready for delivery. Equaling this machine in simplicity of construction are the Cox fence-post and cement-brick machines. The former is shown in Fig. 8. Two men working on it can turn out from 75 to 100 posts a day, and one man can produce from 1,000 to 1,500 bricks on the latter. The compact form of the completed post is shown in Fig. 8 by the side of the mechanism. The mixture is tamped in the usual way, and the machine then removed by pressing the levers on the end. This does away with the necessity of handling the product, which can remain where it is until dry. Likewise simple and efficient is a machine for turning out concrete shingles. An output of from 10 to 12 squares is obtainable on the power, and about two squares per day on the hand machine, at a cost of $2.55 per square. The product is the best yet found, is lighter than clay or terra cotta, can be made in any color or design, and adapted to any style of roof.

The variety of uses to which concrete product made into building shapes is being put shows the possibilities of the block machine. House builders throughout the country seeking artistic, durable, and economically constructed homes, are turning more and more to the concrete cottage as affording the only combination of all these qualities, and here it will not be amiss to show how much can be done at moderate cost in this direction. In Fig. 6 a house put up at Columbus, Ohio, of blocks made on the Hayden automatic machine is a good illustration of high-grade results obtainable at small cost. In this case the expense of putting up the building, which is finished throughout in hardwood and polished pine, reached $4,000, inclusive of the cement walks. It will be evident to the most cursory observer that a cottage like this affords an investment of a permanent character. Figuring five per cent on the cost of the building as a yearly sum necessary for repairs on a wooden structure and unnecessary here, it will be seen that in twenty years the owner will have saved more than the whole cost of his dwelling.

To go back to the machines which make such results possible. The Ideal, a face-down type, seen in Fig. 10, brings into play the use of a lever by means of which the horizontal cores are withdrawn. As shown in the cut, the block is raised on a cast-iron pallet. The face was formerly on the bottom, and is now seen on the side against the faceplate in the rear. To prevent injury to the block in carting away, the makers have provided a carrier which protects it on three sides. This machine is easily portable, and makes any width of block from 8 to 12 inches in lengths of 4, 8, 12, 16, 18, and 24 inches, and can be

Fig. 2.—Tamping Concrete in Hayden Machine.

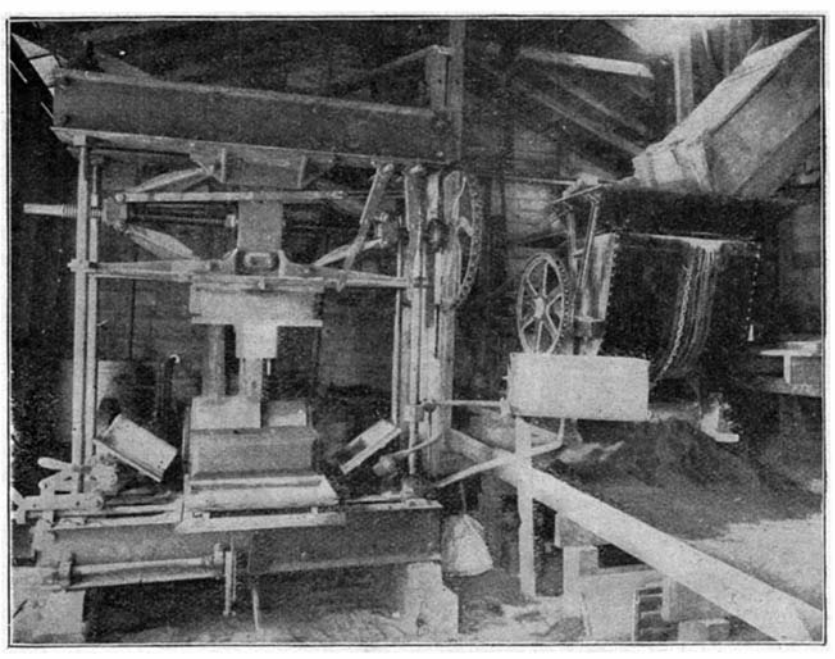


Fig. 4.—Power Machine. Corner Panel Block Ready for Removal.

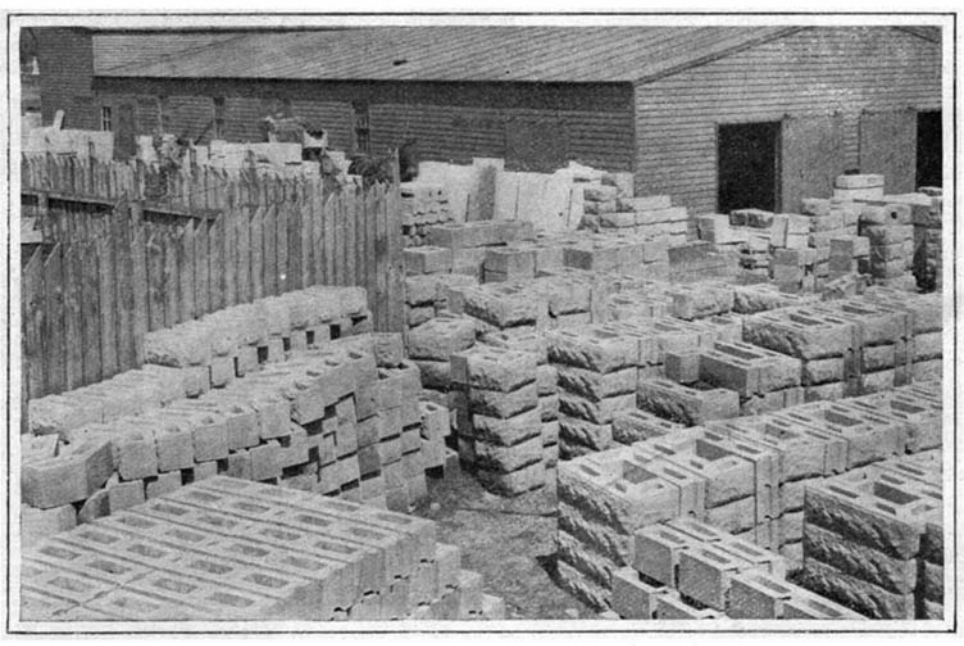


Fig. 5.—A Yard of Finished Concrete Blocks.

adjusted to turn out angle and corner shapes. Somewhat similar to this machine are the Winget and Jackson machines. In the last-named machine the block is made close to the ground, and after being tamped is raised by means of a powerful spring to a table, the core being automatically withdrawn during the process of rising. The sides open automatically, and the block is left on end.

A machine which can be operated by one man, and automatically forms the mold and relieves the block and does both very quickly, is the Walton. This machine turns out "L" blocks 4, 8, 12, 16, 20, and 32 inches in length and 3, 4½, 6, and 9 inches in height, also 10, 12, and 14-foot circles and porch piers. It makes all shapes and sizes on the same pallets.

Capable of making blocks of great diversity is the Noyes F. Palmer machine (Figs. 3 and 9) with its attachments, its molds, 36 different full-size and 288 fractional blocks. Its core holes may be raised from 2 to 6 inches, and being a side-face machine its different face designs are obtained by fastening cast pattern plates against one side-plate of the mold. By a similar means blocks with curved or grooved ends or with faces of different material or color from the body are produced. The completed block on this machine is left in position seen in Fig. 9 by the turning of the two cranks, the upper one throwing open the sides of the mold and the lower withdrawing the cores, and simultaneously elevating the platen which forms the bottom of the mold. To the rear is another completed block.

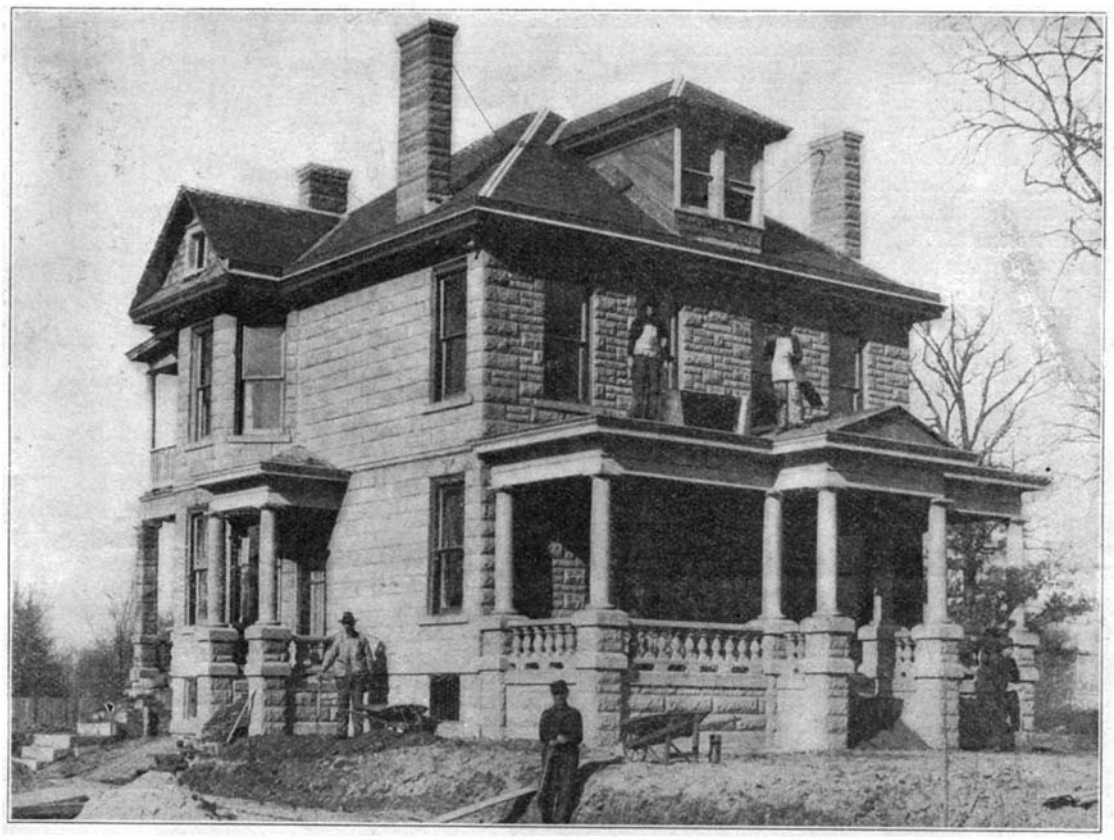


Fig. 6.—A Dwelling Built of Concrete Blocks at a Cost of Only $4,000.

Special time-saving features have been adopted by the various manufacturers, but the trend in all has been to reach a maximum of production with as little complication of parts as is consistent with perfect work. In consequence, the most pretentious machines have adjustable parts, easily and quickly put into place for all lengths and shapes conformable with the dimensions of the mechanism. Embodying these time-saving features with simplicity of construction is the Hayden machine, distinguished for its solidity and compactness and for a low position which renders it possible to tamp in the most advantageous manner. Fig. 2 shows a tamper at work, and the ease with which the mixture is reached. The mechanism is controlled by levers which are simply and effectively operated. When the inside lever has been thrown, the mold is freed absolutely, and the completed block is automatically delivered away from the machine without the slightest jar. In Fig. 1 the advantage which comes from the nearness of the machine to the ground again is evident, the block being in position to be carried away without reaching up or stooping over. A one-fourth-inch space is allowed on every laying side of every sized block. The automatic release of the block insures not only rapidity of delivery, but perfection of form; doing away with inserting and withdrawing the cores and locking and unlocking of molds by hand. The blocks can be veneered effectively. Some of these blocks are seen in Fig. 5.

A type of power machine which its makers claim will turn out one 12 by 24 block a minute is exemplified by the Perfection seen in Fig. 4. The concrete is mixed in this case by a mixer and delivered close to a movable box which is filled and swung over the mold, dropping its contents into it. A pressure of 100 tons is then applied by means of a small engine which operates the entire apparatus. While the block is under pressure the center core is started by a foot lever and raised by the returning follower. The four sides of the mold are released by levers, and the block is removed by a wooden pallet without being disturbed.

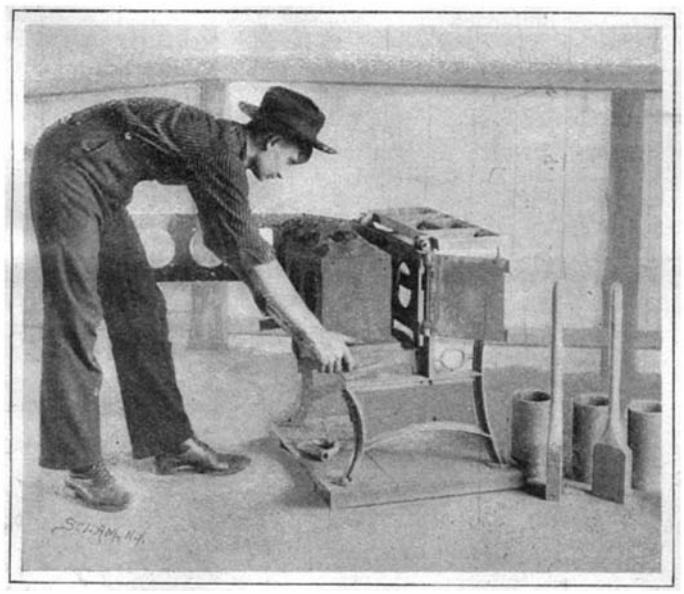


Fig. 7.—The Dayton Machine.

Fig. 8.—Making Concrete Fence Posts.

The twentieth annual report of the commissioners for the Queen Victoria Niagara Falls Park, just presented to the Ontario Legislature, states that the utilization of the falls for power purposes has already reduced the volume of water flowing over by about 7 per cent, or from 222,400 to 205,000 cubic feet per second. Though this has caused no appreciable effect on the falls, a reduction three times as large is in contemplation. The commissioners consider that the public agitation to restrict the further abstraction of the Niagara River water is well founded. The reports show that eleven American and six Canadian companies are at present using the falls for power purposes, and that ten more charters have been given to companies granting them power to use the falls.

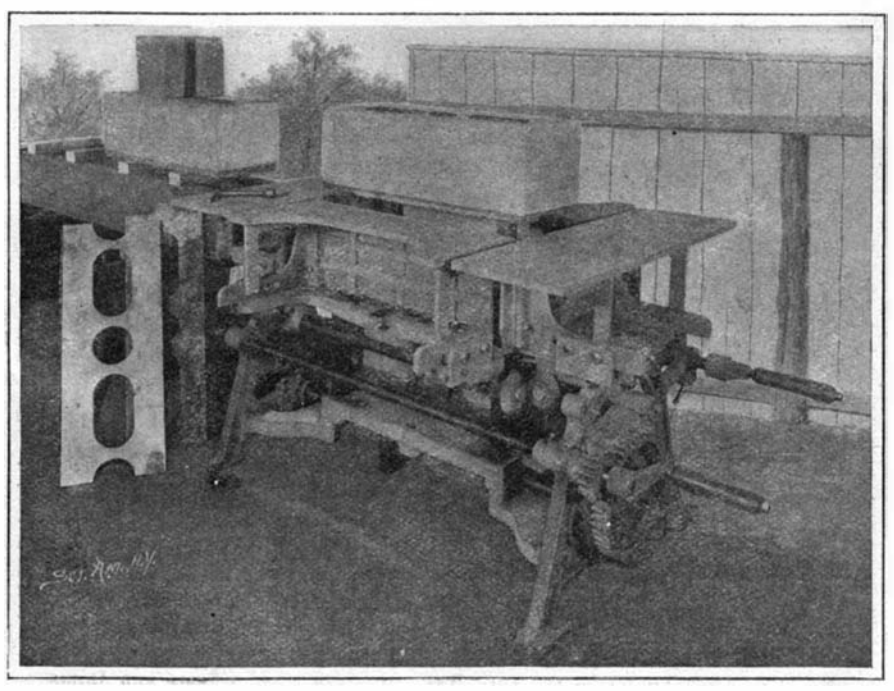


Fig. 9.—N. F. Palmer Block Machine.

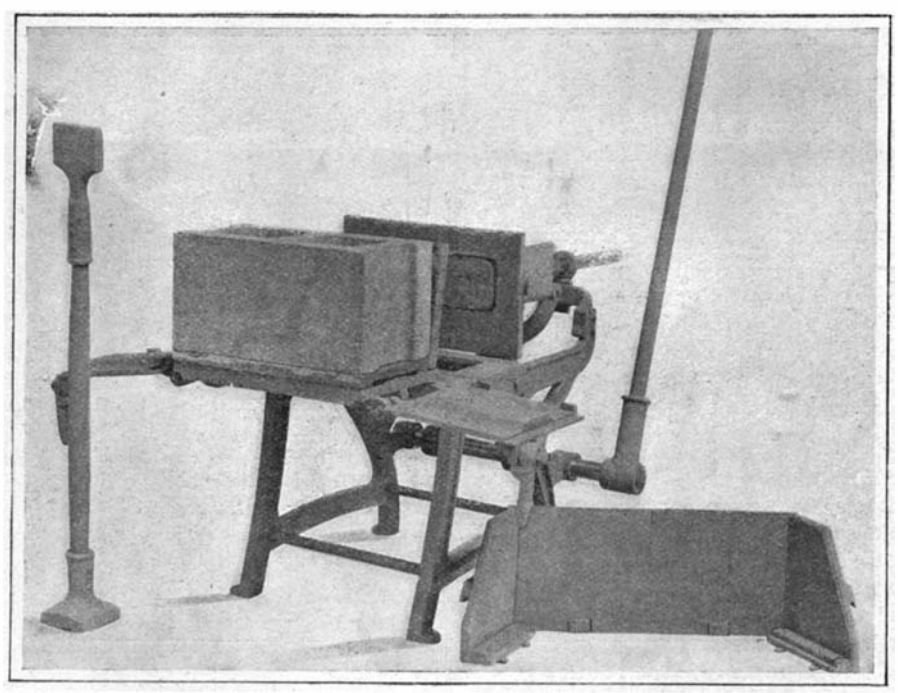
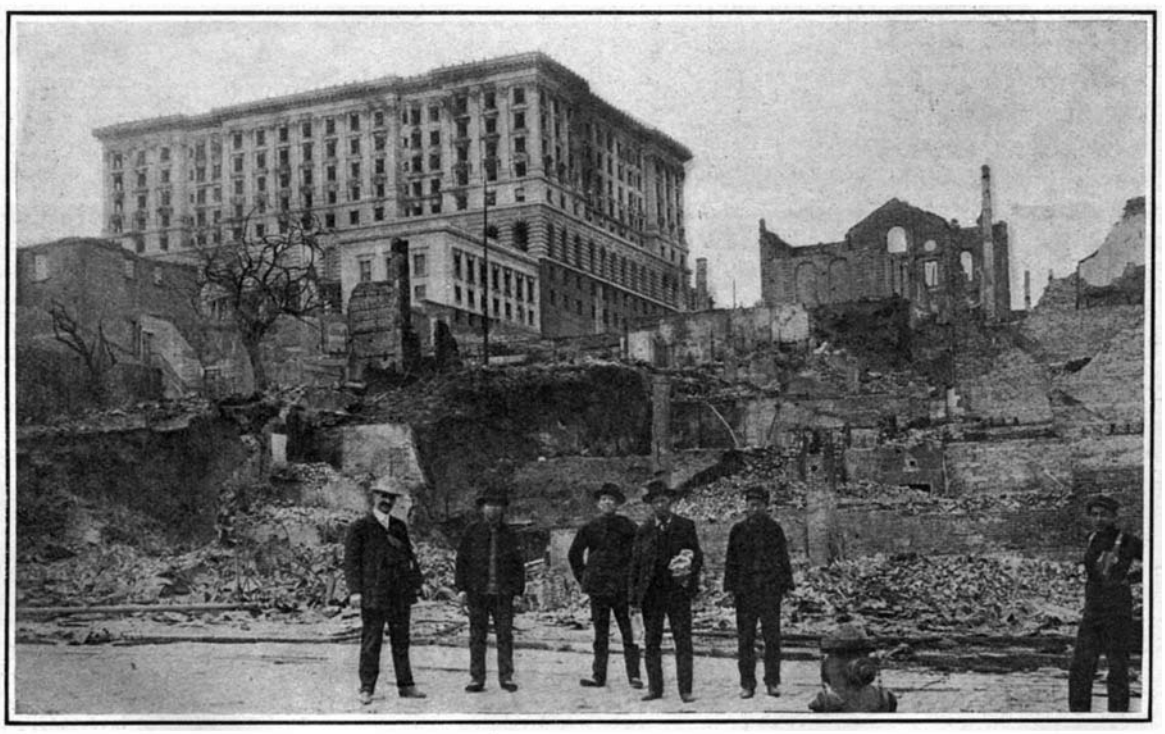


Fig. 10.—Face-Down Machine with Core-Withdrawing Lever.

SOME VIEWS AND LESSONS OF THE SAN FRANCISCO DISASTER.

The remarkable set of photographs of the San Francisco disaster, shown on these pages, tell their own story so graphically as to render any comment upon them almost superfluous. The sight of the steel-and-masonry buildings standing, gaunt and fire-stained, but intact as to their structural integrity, amid the leveled ruins of the older buildings, calls up vividly and at once a visit which the writer made to the ruins of Baltimore, while they were yet smoking at the close of the second day of the fire.



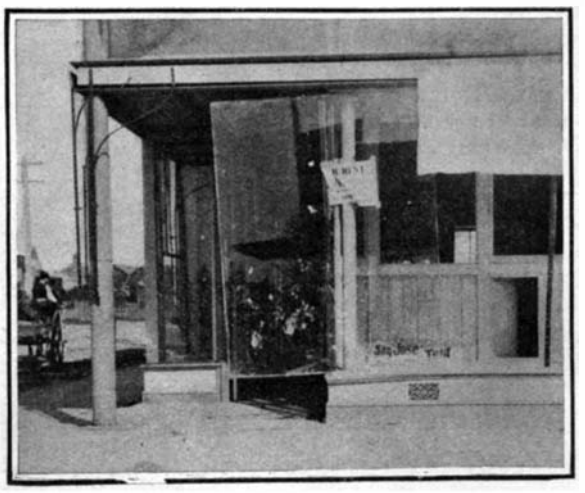
New Fairmount Hotel of Modern Construction Still Standing Amid the Ruins of Older Inflammable Buildings.

The modern steel-skeleton building has abundantly verified the truth of the theories in accordance with which it was built. The engineer and the architect, working together, aimed to produce a building which, by virtue of its enormously strong and highly elastic and well-knit-together steel frame, and the fire-resisting material with which it was floored and clothed in, would be proof against hurricane and conflagration. Incidentally it was hoped, though not confidently predicted, that such a structure would pass through the yet severer ordeal of an earthquake. The Baltimore fire proved the first proposition, and now the San Francisco earthquake has established the truth of the second.

At the present writing, all the evidence at hand goes to show that, in spite of the severity of the shock, the steel frame of the tall office building has come through the ordeal triumphantly. Moreover, in spite of the earlier accounts to the contrary, it now appears (and the accompanying photographs bear out the statement), that the masonry walls, and presumably the fireproof floors, were not shaken loose from the steel framing—not at least, in the tall office and other business buildings. Proof of this, as far as the walls are concerned, is clearly seen in our view showing the Call Building and the new quarters of the Mutual Bank. This fortunate result is to be attributed to the more thorough system of tying the walls to the structure, which characterizes the construction of the latest buildings of this class.

Perhaps the most instructive photograph bearing on this question is the one showing the ruins of the tower and dome of the new City Hall. It will be noticed that the internal steel structure and the metal dome of the tower, even to the figure that crowns its summit, are standing intact, while the two-story circular colonnades, massive though they were, have been almost entirely thrown down. It is probable that the architects trusted to the great thickness and mass of the masonry to give it independent stability, and that it was not very strongly tied into the steel framework. Had the masonry and steel been thoroughly bonded together, we think it is probable that the tower would have been left standing practically intact to-day.

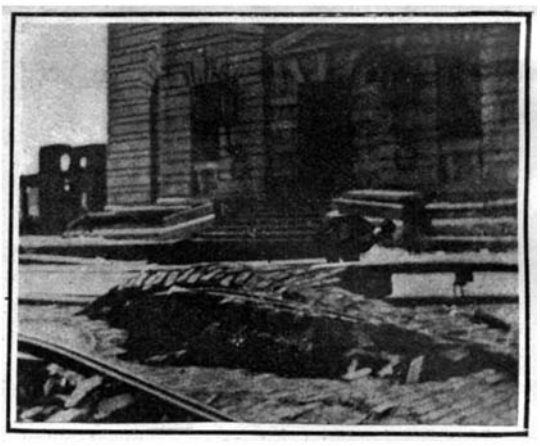
Very impressive is the view showing the great Fairmount Hotel, looking down like a modern Parthenon upon the crumbling ruins which strew the slopes of the hill on which it is built. The earthquake had but little effect upon this costly structure, and what damage it sustained was due to its having been completely swept by the fire. Two of our engravings, those of the Hibernia Savings Society Building and the post office, seem to prove further that a structure which is massively built of cut stone or first-class masonry, if it be of moderate height, can also endure extremely rough usage without any material injury. The damage to the Hibernia Savings Society Building by the earthquake seems to have been slight, and its wrecked appearance is due to its being completely burnt out.



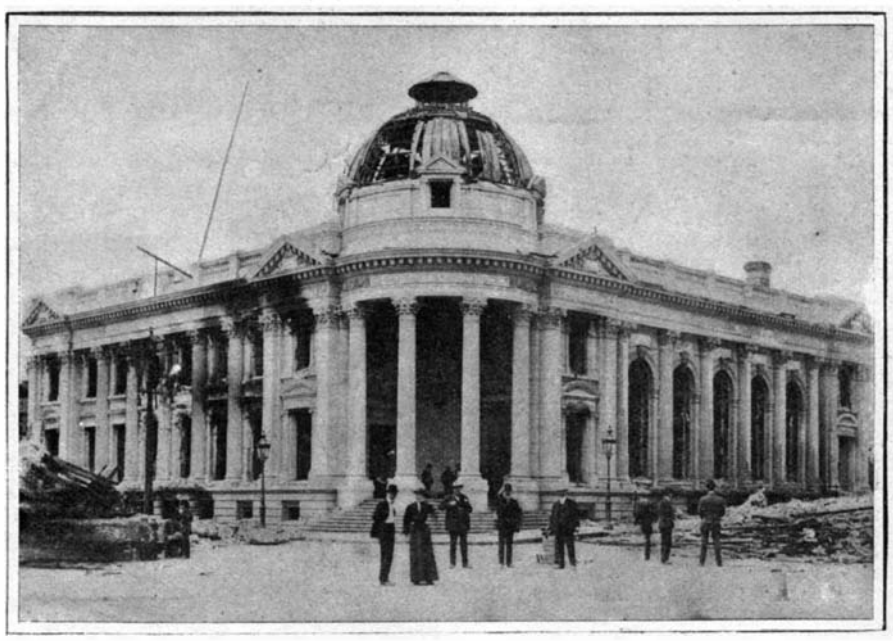
A Window Plate Glass Shifted in Its Frame Unbroken.

The illustration of the post office presents a very remarkable contrast; for while the building itself appears to be in perfect line and level, except in one corner, not shown, which was built over a swamp, the adjoining ground and all parts of the masonry of the building that were not carried by the building foundations proper are greatly upheaved and distorted. How comes it that the building should have stood so unmoved, while the surrounding *terra in-firma* was tossing like the waves of a troubled sea? The paradox is to be explained by the fact that while the sidewalks and streets rested upon either made or filled-in ground, or upon alluvial deposits formed in the ordinary course of nature, the important buildings of San Francisco such as this stood generally upon foundations which reached down to the underlying rock, or to a bearing upon a stratum which in immobility and sustaining power was equivalent to rock. It is possible that when the seismic tremors passed through the earth, there was no great permanent displacement of the rock. But the made ground and the alluvial soil were relatively unstable; and when the underlying rock was shaken, the overlying material was thrown into waves and ripples, much in the same way as the surface of a fluid is agitated if the receptacle that

Crevice and Subsidence of Car Track.



An Upheaval of Street Car Tracks.



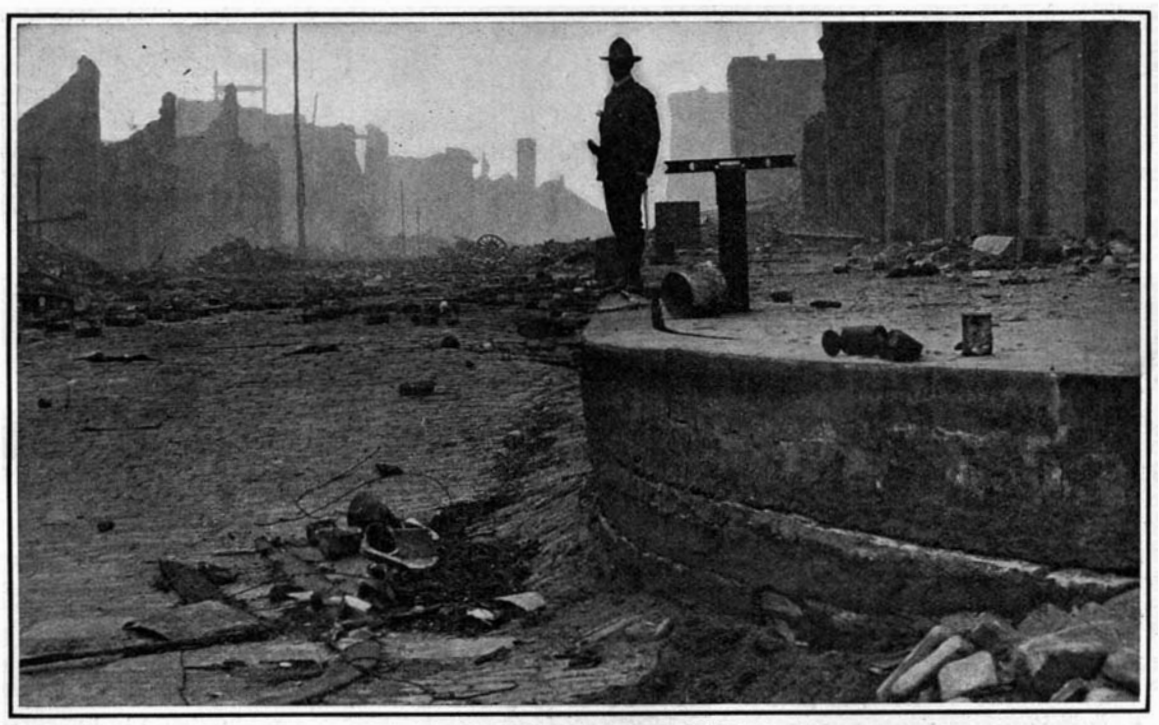
Hibernia Bank. Damage to This Building was Mainly by Fire.

Effect of Earthquake on the City Hall, Showing Steel Frame and Dome Intact; But Masonry Thrown Down.

holds it be shaken with rapid oscillations. When the shaking is over the fluid will resume its normal level; but the loose overlying alluvial material above the underlying rock, not having the fluidity or ease of the readjustment of the water, will permanently retain many of the hollows and billows produced during agitation. An excellent illustration of this action is shown in the sidewalk surrounding the post office, and in the upheaved and depressed tracks pictured in two of our smaller cuts. So also a view taken in Market Street shows that the whole mass of filled-in material of the street has been shaken down some five feet, just as grain or other loose material may be shaken down in a sack or other receptacle.

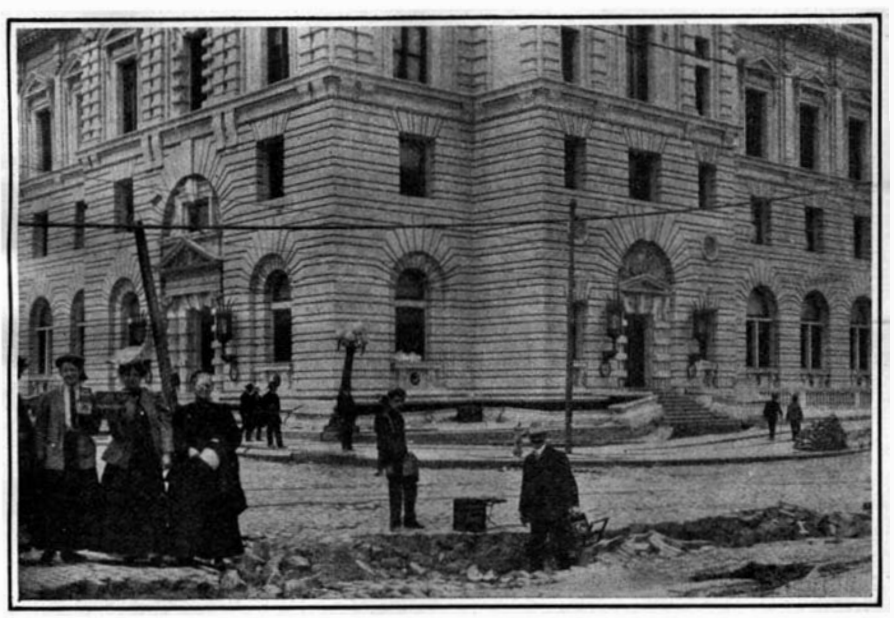
In this connection we may say that we have little doubt that the great length of the flexible wooden piling extending from the base of the tall office buildings in the lower part of San Francisco down to the firmer material, served, because of its elasticity, greatly to cushion and absorb the violence of the oscillations of the underlying rock as they were transmitted through the piling to the steel structure.

After all is said and done, it was undoubtedly the fire and not the earthquake that destroyed San Francisco. This is evident from a study of the photograph taken from the hills back of San Francisco, showing the destruction of the business section. The only visible evidence of the earthquake is the fallen chimneys; the wooden buildings, at least in this section of the city, appearing to be but little harmed. The earthquake did its work in smashing the water mains and cutting off the water supply, and the fire did the rest. Here there is another problem which should receive the most serious consideration of our hydraulic engineers. In the rebuilding of the water mains, the greatest possible use should be made of mild-steel, riveted piping, supplied at frequent intervals with flexible joints. We believe that mains of this character would readily adjust themselves to the twisting and displacement of the ground in which they were laid, most of the adjustment taking place at the joints; while the piping itself would suffer an extraordinary amount of distortion before fracture took place. The following account of the behavior of the various types of construction under the fierce test of the conflagration is from the pen of our special correspondent in San Francisco, who writes us that sufficient was known at that time, Saturday, April 21, of the condition of those buildings which survived the earthquake and the subsequent conflagration, to afford a complete and satisfactory test of the stability of different classes of building material employed in their erection. For once and for all time the popular belief in the incombustibility or slow-burning qualities of redwood lumber was shattered beyond recovery and its use will probably be prohibited, at least in down-town districts, for all future time. The writer remembers distinctly the fire in Chicago and the results, displayed on that occasion, of employing pine lumber in building construction and unhesitatingly pronounces the redwood to be in every way as objectionable as pine in the fierceness of its flame, quickness to ignite, and the intense heat arising from its combustion. In only one particular was the fire in Chicago worse than in San Francisco. In Chicago the wind blew a hundred miles an hour and with such force as to lift whole sections of burning wood which it carried away blocks in advance and ignited wherever it chanced to alight. By this means the fire spread more quickly in Chicago than in the



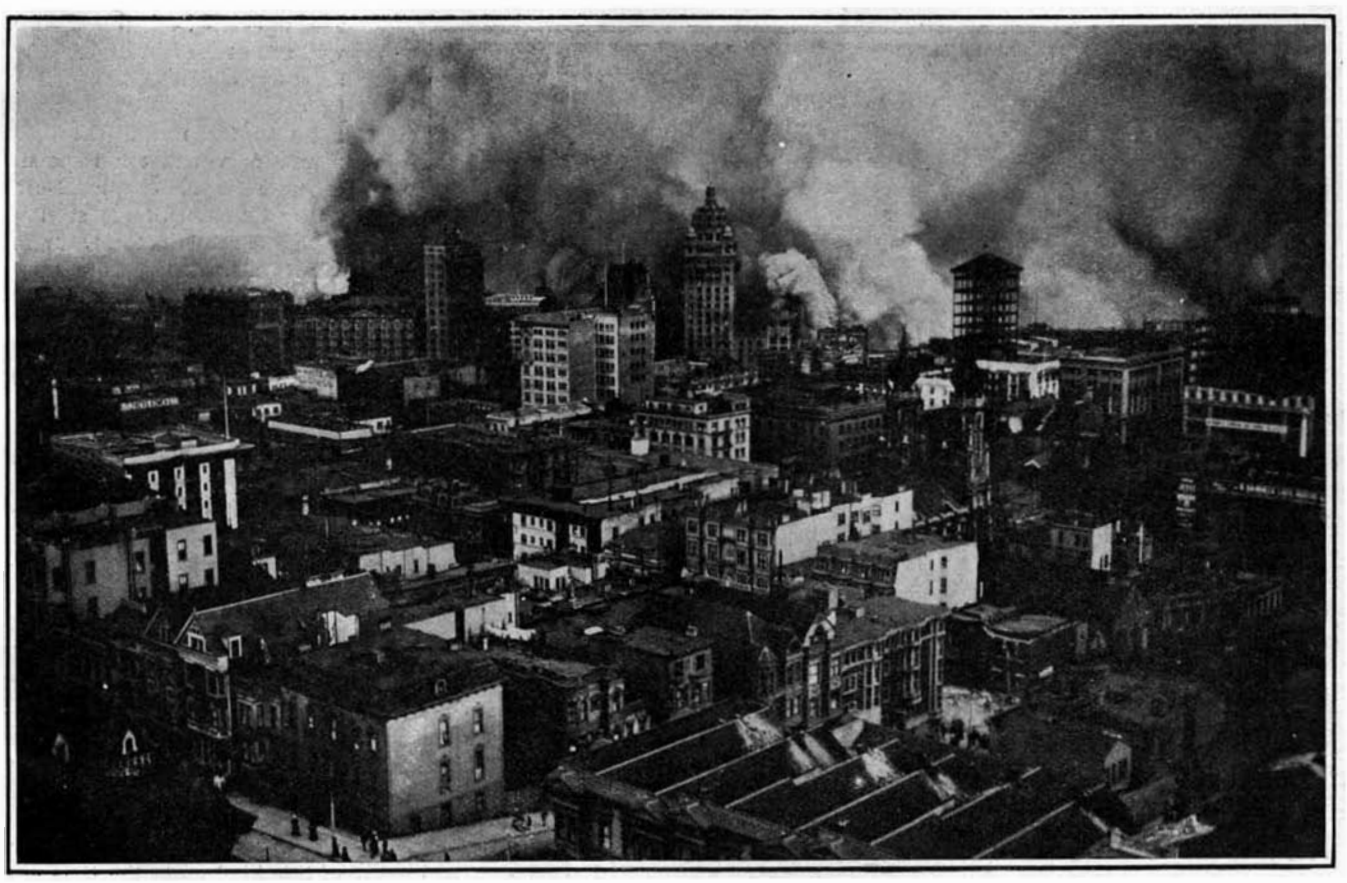
Copyright 1906 by Graham.

Freak of Earthquake. Market Street Sinks Five Feet Below Curb.



The Post Office Suffered Little. Only Sidewalks Are Twisted. Note Fissure in Which Man Stands.

View Showing How Well Steel-and-Masonry Buildings Stood the Test of Earthquake and Fire.



The Burning of the Business District as Seen from the Hills.

SOME VIEWS AND LESSONS OF THE SAN FRANCISCO DISASTER.

latter city, where its progress was more gradual but not the less certain. Streets a hundred feet wide offered no obstruction to the fire spreading, for the intense heat of the redwood caused the buildings opposite to ignite as soon as the fire gained requisite strength. On Mission Street wood construction predominated, and with this street as an axis the conflagration spread in other directions. Had there been no redwood the business district might have been saved.

Among the more prominent buildings destroyed, taking them in regular order, was the New Merchants' Exchange, finished January 1, 1905, fourteen stories in height and of steel construction, faced with granite on the first floor and with terra-cotta brick for those above. The earthquake caused the building but incidental damage, but fire subsequently gutted it completely. It is now believed that the frame of the structure is intact and can be used again. The terra-cotta is apparently but little injured.

The Union Trust Company's bank, at Market and Montgomery Streets, fifteen stories, lately completed, steel frame, terra-cotta facing, will be occupied for business in a few days, as, the writer is informed, will the Crocker Building, opposite, of like construction, which stands but little injured, apparently only needing new finishing for the inside.

The Palace Hotel was built before the adoption of steel-frame construction, but with solid brick walls which stand and can be made available if desired.

The new Chronicle Building, unfinished, sixteen stories, steel and terra-cotta, will be as good as new with interior furnishings replaced; the old part, however, fifteen years old, steel and brick, is in a precarious condition and will probably have to be demolished.

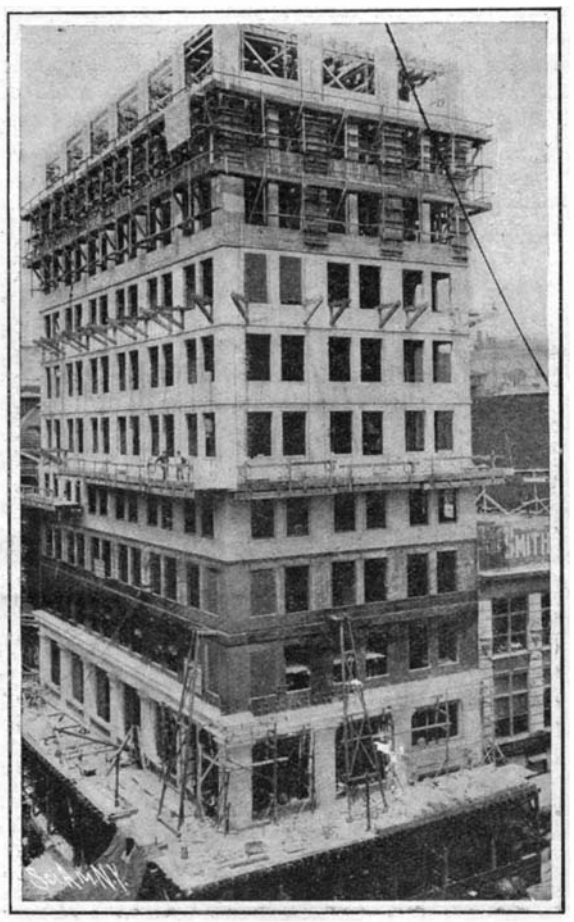
The lofty Call Building was subjected to an intense redwood flame, but stands upright and majestic. The Colusa sandstone with which the structure was faced is badly disintegrated by heat, but the frame is said to be intact and may be used again.

The James L. Flood Building, Market and Powel, just completed at a cost of $2,500,000, was badly gutted, though the steel frame is in perfect condition as far as can be judged. This building was faced with Colusa sandstone, which offered but little protection owing to the intense heat.

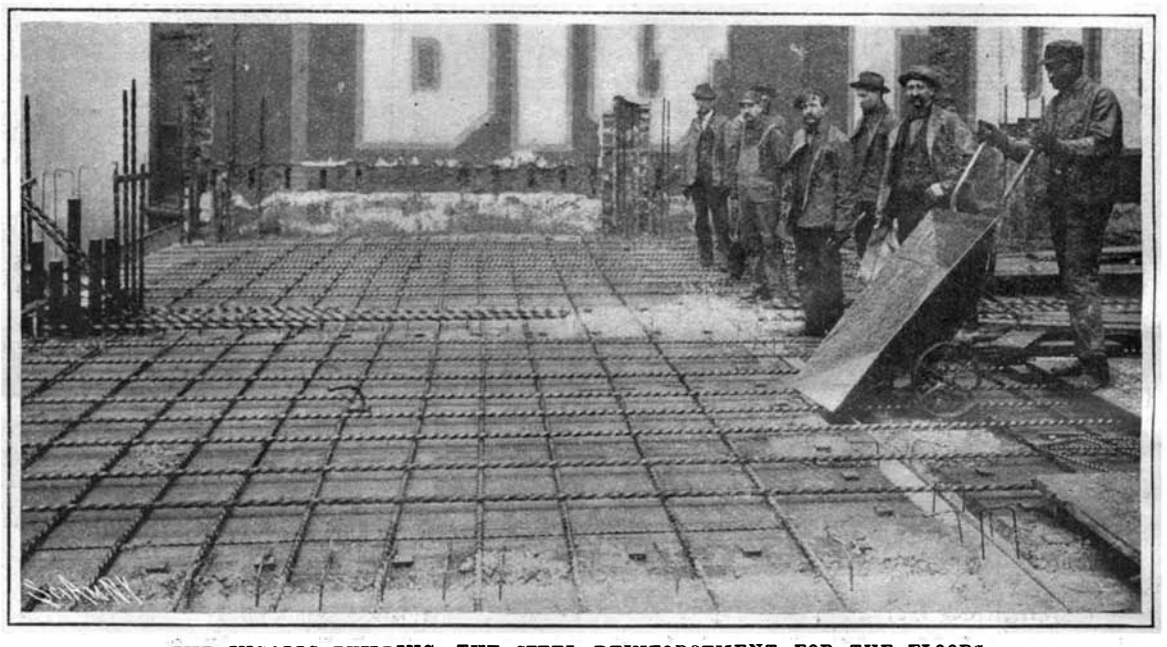
The Ahronsen Building at Mission and Third Streets, finished one year ago, ten stories, steel frame, terra-cotta brick faced, with interior replaced will be good as new, though not subjected to the intensest heat, as it was surrounded with low buildings in every direction.

The "Fairmount," of steel and terra-cotta, unfinished, is comparatively little injured, and with interior renovated can soon be occupied.

With these examples it would appear that terra-cotta is far and away the best exterior material for buildings of any height. No stone that was ever quarried can withstand the intense heat of a general conflagration. Though ordinary clay brick of good quality is almost equal in fine-resistance to terra-cotta, as proof against an earthquake shock brick is no better, if as good, as stone.

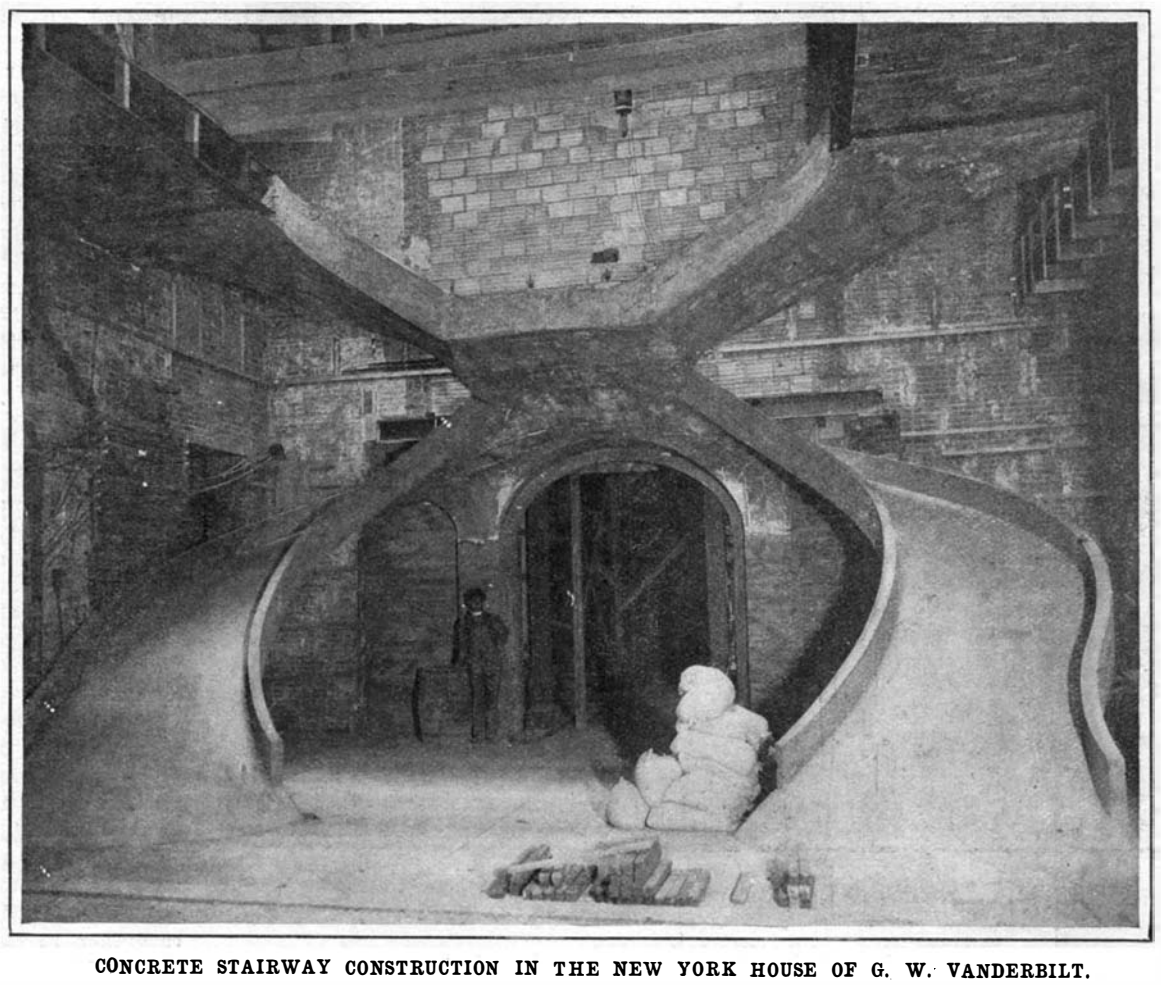


THE INGALLS BUILDING—COMPLETING THE ELEVENTH FLOOR.



THE INGALLS BUILDING—THE STEEL REINFORCEMENT FOR THE FLOORS.

Brick and stone buildings of the past were useless, and as easily demolished in the San Francisco fire as a paper box.



CONCRETE STAIRWAY CONSTRUCTION IN THE NEW YORK HOUSE OF G. W. VANDERBILT.

A STAIRWAY OF REINFORCED CONCRETE.

One of the possibilities of reinforced concrete is interestingly shown in the accompanying illustration from photograph taken during the construction of the main stairway in the New York house of Mr. George W. Vanderbilt. The stairway was designed by Hunt & Hunt, architects, and was built by the Turner Construction Company as sub-contractors. In the engraving the body structure of the stair is shown completed, but without the treads, sides, rails, etc. The stair is double, two branches starting from the ground floor, and rising in graceful reverse curves to meet at a landing somewhat more than half way to the story above. At the point of meeting of the two branches the stair touches the wall toward which the two lower branches curve, and is supported by the wall at the point of contact. Two branches again start from the landing, curving in a direction transversely across the corresponding lower arms to the floor above. The entire stair is supported at only one point between the floors, and that is where it abuts against the wall. All intermediate columns have thus been avoided, for these would not have been in harmony with the design. Had the stair been built of steel, it would have been impossible to obviate the intermediate supports except by making the structure exceedingly heavy and bulky, a feature which would have been objectionable.

The construction is on the Ransome system, in which the concrete is reinforced by longitudinal and transverse bars of twisted steel carried into the supports where necessary, and with the individual members, where possible, tied together by wire. The longitudinal bars, both in the body and the sides, are bent to conform to the curvature of the stair, and are continuous from the intermediate landing to the floor above and the floor below. The transverse rods are spaced short distances apart, and have their ends bent at right angles to project into the lateral flanges, clearly shown in the photograph. The concrete construction is carried out to engage with the I-beams in the wall and at the second floor landing, and thus is formed an extremely solid bond. The design is not considered by engineers a difficult one to execute, notwithstanding that the result is rather a freak structure. It merely proves that it is possible to build anything of concrete for which a mold can be constructed and set up, and that with the steel reinforcement the resulting structure is not only strong, and solid, but is often less cumbersome than a corresponding one built entirely of metal. In the present case, if the stair had been built of steel, it would have been necessary to design and manufacture each piece separately, with a consequent loss of time and at greatly increased expense.

The stair is designed for a live load of about 150 pounds per square foot, and was found to answer all requirements in a thorough series of tests, in which heavy bags of cement were dropped upon it at various points from a height of some 12 feet. The stairway was finished in white marble with brass railings, and the structure has turned out to be not only a pre-eminently practical one, but an extremely handsome piece of work as well.

THE INGALLS BUILDING — THE LARGEST CONCRETE OFFICE BUILDING IN THE WORLD.

Among the earlier large concrete buildings in this country is the Ingalls Building, of Cincinnati, designed for office, banking, and telephone exchange purposes, and undoubtedly the most ambitious structure of this kind up to the time of its construction. It was begun on October 2, 1902, and completed late in the following year. It has sixteen stories, a basement, a sub-basement, and an attic, measures 100 x 50½ feet, and rises to a height of 210 feet from the sidewalk

to the cornice. The distance from floor to floor is 12 feet 6 inches for the office stories, and 17 feet in the telegraph exchange on the sixteenth floor. The concrete construction as compared with a similar structural steel design permitted a reduction in height of about one foot for each story, a saving due to the shallower floors. The construction is on the Ransome system, in which the concrete is reinforced by rods, bars, stirrups, and hoops of twisted steel, is solid and continuous throughout, and was essentially completed as the work progressed, the rate at times being one entire story finished every twelve days. The foundations are of the spread type, and rest upon a good stratum of gravel and sand.

The boldness of the structural design, at least for that period in the development of the use of concrete, is well shown by the spacing of the columns, which is such as to require girders of 16 to 33 foot span, and floor panels 16 x 33 feet between the main girders. The columns are 16 to 33 feet apart, center to center, and decrease in size from 34 inches by 38 inches at the basement to 12 inches by 12 inches at the roof. The footings vary in size according to position and loading, and are built independent of the columns. Each has a rectangular pedestal, slightly greater in horizontal dimensions than the column, and upon this is a cast-iron base plate provided with circular projections to form top seats for vertical round steel bars imbedded in each column to add compressive resistance thereto. Each column, according to its size, has four, six, or eight such bars, 2 to 3½ inches in diameter, of which have upward inclinations. These grooves engage with ribs of similar section on the face of the concrete, and thus form a species of dovetail joint. The exterior window and door frames are of cast iron for the first floor, and of sheet iron for the remaining stories. There are four hydraulic elevators running in concrete wells for passenger and freight purposes, and two for use in connection with the floors below the surface level. The space beneath the sidewalk is utilized, and in this connection concrete retaining walls are employed.

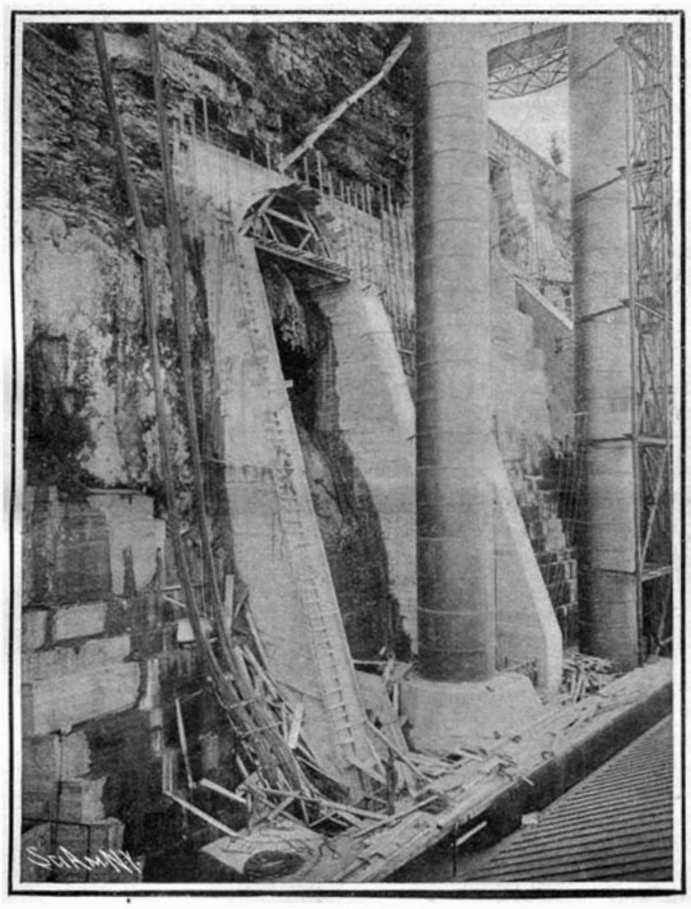
For the installation of the concrete steel construction, three stories of interior forms and two stories of exterior forms were used. The method of employing these forms is illustrated in the first of the accompanying engravings. The interior forms of each story were removed in twenty-one days, and were used for the construction of the third story above. The exterior forms were removed in fourteen days, and applied in the construction of the second story above. At the time the photograph was taken the ninth floor, with its beams and girders, and the columns of the story below, had been completed in about twenty-three days, and its interior forms had been raised to be used for the twelfth floor and the eleventh story columns. The exterior forms for this floor had been raised from the tenth floor and the ninth-story columns, which were completed in about fourteen days. As the forms were raised, the portable scaffold, shown at the tenth and eleventh floors, was raised coincidentally with the forms.

the tops of the bars below, with a joint made with an inclosing pipe sleeve filled with neat cement. At this point also may be seen the method of employing twisted steel uprights, diagonals, and horizontals in the columns and tops of girders at the supports, to resist wind and floor load stresses. In the foreground are shown the twisted steel U-bars used to assist in withstanding longitudinal sheer in the girders.

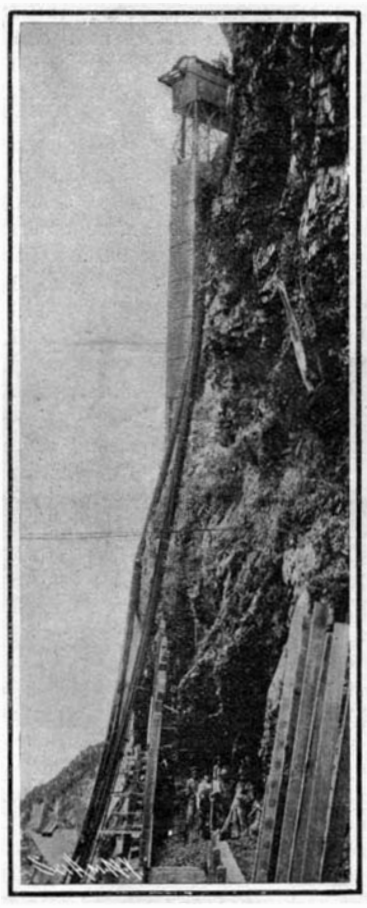
A GREAT CONCRETE RETAINING WALL.

BY ORRIN E. DUNLAP.

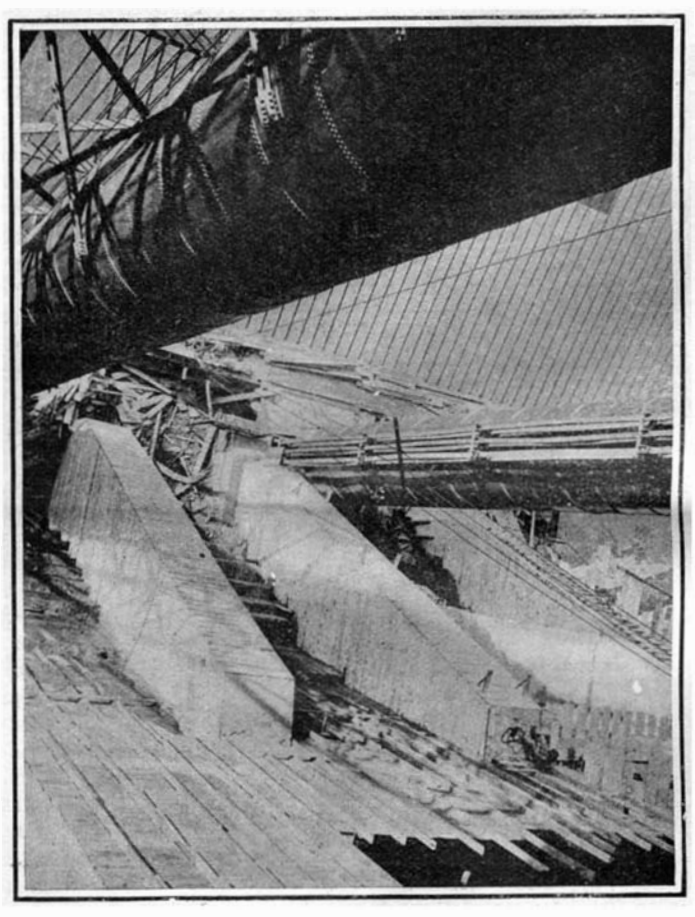
What is believed to be the highest concrete wall in existence has just been completed by the Niagara Falls Hydraulic Power and Manufacturing Company at Niagara Falls. This remarkable work was made necessary by the slow but constant deterioration of the cliff to the rear of the company's power station, which is situated at the water's edge in the gorge, on the New York side of the river below the upper steel arch bridge. At this point the talus or apron of fragments has been cleared away to make room for the power house. The cliff is vertical, the rock being limestone at the top, resting on gray shales, which the rain and frost more or less affect. It is claimed by geologists that the recession of the Falls of Niagara is due to the destruction of the shales, leaving the heavy limestone without the support of the softer rocks beneath, so that from time to time huge blocks break away and fall into the river below. To-day, where it is possible to look under the sheet of falling water of the Falls, the limestone would evidently be



The Highest of Concrete Walls.



Character of Cliff Above the Wall.



Bird's Eye View of the Pilasters of the Concrete Wall.

A GREAT CONCRETE RETAINING WALL.

and the joints of these are formed by faced ends in contact. Besides, each column has four to ten twisted steel bars to resist tensile strains due to wind pressure loads, and rectangular hoops, lapped and tied by wire, to bind the bars at vertical intervals of 12 inches.

As mentioned above, the main girders between columns are of 16 to 33 foot span, and those of the first floor, including floor slabs, have a depth of 36 inches, those of the second floor 34 inches, and all above the latter 27 inches. The width throughout is 20 inches. They are formed monolithic with the walls, columns, and floors, and the extremities of their horizontal steel rods project into the columns between the vertical reinforcing members of the latter. The girders are additionally strengthened by alternately inverted U-bars of twisted steel. The junctions with the columns are reinforced by vertical diagonal twisted bars, from the top of the girder downward, and from the bottom upward into the body of the column, the lower ones being concealed in concrete brackets.

The exterior walls, exclusive of facing, are 8 inches thick, with the exception of those in contact with the walls of adjacent buildings, and these are from 3 to 4 inches thick. All are reinforced by vertical and horizontal twisted steel bars. The exterior facework is of 4½-inch marble for the three lower floors, and above these of glazed bright gray brick with terra-cotta trimmings. The brick facing is supported at each floor by a ledge formed in the concrete, and is also secured by wire anchors projecting from the concrete. The marble facing and the terra-cotta trimmings are provided with grooves in the back, the top and bottom surfaces

At the fifth floor level may be seen the swinging scaffold employed by the general contractor for the brickwork. At the second story is shown the marble facing and its strap-iron anchors projecting from the concrete wall. These anchors, which were used in addition to the dovetailing described above, are placed at joints in the marblework, and each has a small steel pin which passes through a hole in the anchor and is fitted into a recess cut into the marble. The black waterproof paint, seen at the third story, was employed to insure the marble against the possibility of stain from the concrete. This paint was applied at the time when the forms were removed, thus offering a means for a thorough inspection of the surface of the concrete as the building progressed and as the load increased. It is claimed that this paint has since remained in as perfect a condition as when first applied. All the stories up to and including the ninth were in the process of being plastered, and all other branches of the work, such as the installment of the marble-work on the floors, doors, and partitions, the heating, plumbing, and electric work necessary for completely furnishing the interior, were being completed, for each floor formed a perfect roof as soon as concreted.

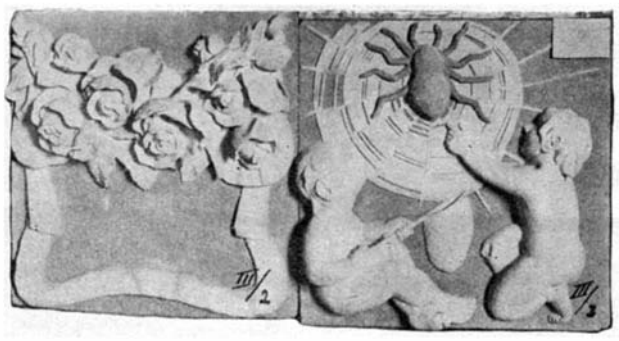
The second photograph is a view of the third floor, showing the beam and girder forms filled with concrete, and the completion of the floor above about to be accomplished. At the extreme left is shown the method of providing round steel bars to furnish compressive resistance that the area of the column may be reduced. The bars are carried to a point from 6 to 18 inches above the floor level, and rest directly on

without support; that it projects out shelf-like, and no doubt will in time break away. Knowing that this action was taking place at Niagara, the Niagara Falls Hydraulic Power and Manufacturing Company felt that in time the deterioration of the shale back of its power station would injure the strength of the supports of the limestone above, and thus endanger the retaining walls of the forebays, while the possibility of falling rocks was a source of danger to the power house as well as the employes and workmen about the power station at the water's edge. While this prospective danger was unquestionably a very long way off, the realization of its occurring caused the company to take careful steps to avoid it, thus anticipating any likelihood of injury to its employes or power station.

It was these conditions that resulted in Chief Engineer John L. Harper designing the facing wall referred to. He found that the cliff had previously been faced up to the shale, at which time the possibility of extending it to the top was not considered. It was therefore deemed advisable to construct three pilasters to give the upper and heavier parts of the facing wall a more stable support. The wall is made of 1--3--5 concrete filled with a clean rubble. Its length is about 200 feet, and it is not less than two feet thick at any point. The wall drops to the level of the tail water, and extends fully 150 feet above the eaves of the power house, which are 30 feet high, making a facing 200 feet high composed of about 7,000 cubic yards of concrete. The pilasters are 5 feet wide and 80 feet high. In places the wall has a thickness of as much as 12 feet.

A series of experiments made by Chief Engineer Harper would indicate no danger of the water, resulting from seepage, freezing behind the wall, as it was found that the water never attained a lower temperature than 39 deg. F. at the outside of the bank in the most severe conditions of wind and weather. The removal of the water is abundantly provided for by means of weepers.

In one of the accompanying pictures of this notable work an arch shows. This was built for the purpose of protecting a natural grotto, in which a spring is located. This has been most successfully accomplished without in any manner detracting from the strength and usefulness of the facing wall, by arching the grotto.



Bas-Relief Made With One Part White Cement and Three Parts of Sand.

Bas-Relief Stamped in a Mold of Plaster and Made With One Part White Cement and Four Volumes of Sand.

It is worthy of note that all the sand and stone used in this construction was dumped on the east side of the terminal railway tracks about 300 feet back from the edge of the bank, from which point it was carried by means of an aerial cableway to a concrete mixer that stood near the edge of the bank. The mixture was dumped into chutes that carried it to the point of use, without causing a separation of the concrete mixture, the mass sliding as a unit in the chutes which were steep, smooth, and small. The scale on which the work was done called for the placing of from 80 to 90 square yards of concrete every day.

THE ARTISTIC POSSIBILITIES OF CEMENT.

The use of cement is becoming more and more important, not only to the architect, engineer and builder, but also to the artist, for plastic and sculptural purposes, and few realize that, unlike Italian terra-cotta, it can be made to withstand the rigor of our northern winters, and is equally impervious to heat and dampness. With certain treatment, a color, texture and durability is obtained, reproducing to a remarkable extent the old stone figures of another age.

In a recent visit to Mr. W. R. Mercer's studio, the writer was able to convince himself of this. Hitherto, cement for plastic purposes has been of a cold, gray, flat tone, which did not lend itself to the ancient forms and ideas, but after some years of experiment, Mr. Mercer seems to have found a method by which he overcomes this defect. The lover of art is thus able to have within his reach some of the famous examples of ancient sculpture at a naturally much reduced price.

In the studio one may see fonts, urns, busts, bas-reliefs, etc., all destined for the decoration of a garden, which is Mr. Mercer's specialty. One of the great troubles encountered at the beginning of his experiments was the making of a mold that would incase the cement and not take it in so close an embrace as to render its release impossible without breaking the cast. This problem was solved by the use of flexible molds, prepared in such a way as to avoid the repeated failure caused by the casts sticking and the cement not properly hardening before the disintegration of the composition used in the mold.

It is hard to enumerate the difficulties that beset the artist at this juncture. Cement is a non-combustible, hard, very durable and cheap material, which can be cast in a cold state by simply mixing with water—hence its great adaptability to the fine arts. It is, however, less ductile than plaster of Paris, and though this difficulty has been overcome by stirring, pressure and other methods of application, its gray color and unsympathetic texture have chiefly repelled the artist. In combating the color certain pigments vitiate the strength of the cement, others do not. Some act chemically upon it so as to transform the tint of the mixture. Certain cements neutralize or weaken when colored more quickly than others, while the rapidity with which the cement dries, whether in the sun or dark, or whether more or less subjected to dampness, will be found to influence the color, or even vary the natural gray tone itself. Further, the method of application of the color, whether injected entirely through the cement before setting, applied during setting from the mold, or incrusted upon the latter in a comparatively thin envelope during setting, modified the result.

As to the texture, certain masses of cement, falling upon the earth outside of molds, or hardening inadvertently in bags and boxes, have assumed this texture of stone, while other masses present a very unpleasing nondescript surface. When molds are used this non-ductility of the material requiring stirring may blotch the surface with areas where the finer particles seem to have collected in a sort of paste. On the other hand, when cast too dry, the cavities are not properly filled. Owing to these difficulties the cement will not always take the texture of the mold, therefore one must resort to other means. The mold itself may be incrusted with ingredients which will communicate their texture to the cement, or materials, coarse and fine, may be introduced into the original mixture so as to modify the result. In a word, the cement is merely a glue causing the gravel and sand to adhere to each other, and is used as a medium and not as a base. The process, which any one can work out for himself if he wishes, lies almost entirely in the adding of certain ingredients to the raw cement. The texture and color are matters of workmanship and taste. When the process is learned it will be possible to reproduce almost any work of art with the accuracy of the copies seen in the illustrations. Once the mold is made there is practically no limit to the number of reproductions.

The production of a white cement has been the endeavor of many investigators, and even at the present time, the problem cannot be considered completely solved. It is the powerful coloring action of the iron which has proven to be an insurmountable difficulty in the practical utilization of many a good idea. It has been an undoubted step forward that Julius Gresley, of Liesberg, Switzerland, contents himself with the production of white Roman cement and does not attempt to produce white Portland cement in which the high burning temperature and the hardness of the clinker substantially increased the chief difficulty mentioned. White cement will probably be always used for the attaining of artistic effects, and for this purpose the strength of Roman cement is quite sufficient. Gresley mixes clay free from iron, particularly kaolin and pipe clay, with lime in such proportions that the clinker is constituted according to the chemical formula

$$x(SiO_2 2CaO) + y(Al_2O_3 2CaO) \text{ or } x(SiO_2 2CaO) + y(Al_2O_3 2CaO) + 2(SO_3CaO)$$

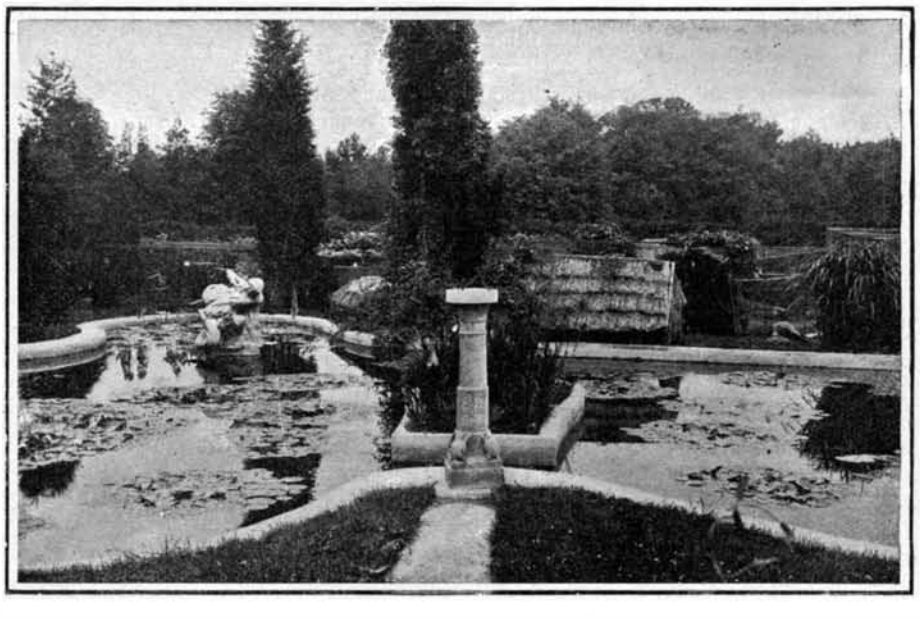
and thereby attains a white cement, answering all proper tests in regard to tensile and compressive strength and which either with or without added coloring matter, lends itself excellently for decorative purposes. We publish herewith two illustrations from photographs of decorative work made of "Marbrit," the name under which the raw material for the production of the Gresley white cement is known, and these show the excellent results obtainable with this substance.

The Figure and the Pedestal are of Cement.

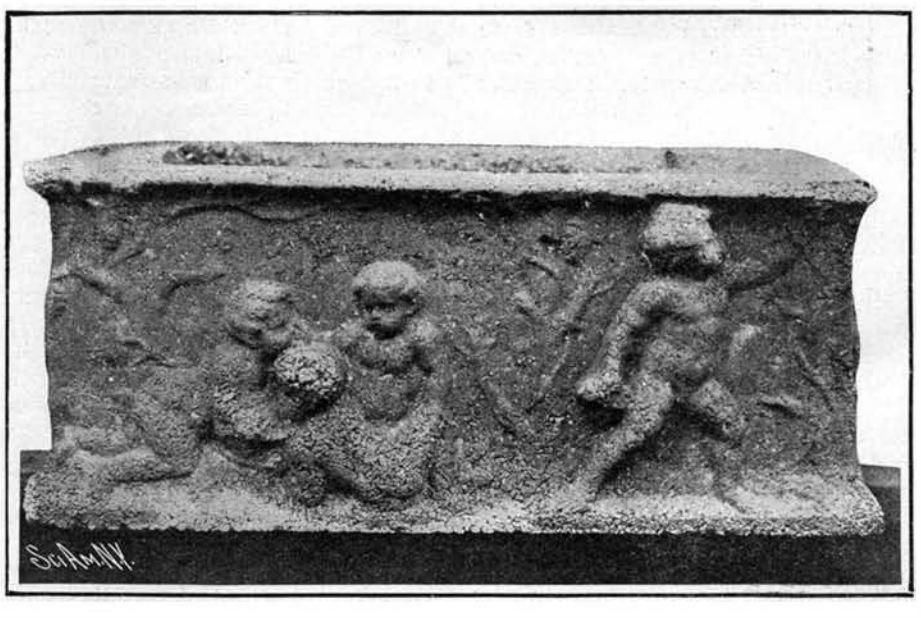
The Genesis of the Chauffeur.

Chauffeurs existed, says Figaro, long before there were automobiles. History tells us that along about the year 1795, there sprang up in France, principally in the eastern and central regions, fantastically dressed men with their faces blackened with soot and their eyes carefully concealed, who gained admittance to farm houses and other isolated dwellings at night and committed all kinds of depredations and outrages. They had an atrocious habit especially, from which they obtained the name that posterity has preserved for them. They first garroted their victims, and dragged them in front of a great fire, where they burned the soles of their feet. Then they demanded of them where their money and jewels were concealed. Such interrogatories could scarcely be resisted. It is from this that is derived the appellation of "chauffeur," which once so terrified old ladies, but which at present evokes in us only cheerful and pleasing thoughts of automobilism, and of voyages and excursions at twenty-five and thirty miles an hour, in which there is nothing but the roads and paved streets that are scorched.

Aluminium and lead will not alloy. They mix when melted, but separate when cooling.



A Sun Dial Cast in Cement in Imitation of the Font of Turtles.



A Cement Flower-Box. The Original Has Been so Closely Imitated That Even the Wear of Time Has Been Reproduced.

THE ARTISTIC POSSIBILITIES OF CEMENT.

The Hayden Automatic Concrete Block Machine, showing the method of making the block face downward. The next movement delivers the block away from the machine and on its side.

In addition to all the advantages offered by all other machines, the Hayden Automatic Concrete Block Machine offers the following *exclusive* features :

1. It is the only down-facing machine that makes concrete blocks in *all* lengths up to 36 inches and delivers the blocks away from the machine.
2. It is the only down-facing machine that makes concrete blocks in all widths of faces up to 12 inches and automatically delivers the finished block away from the machine.
3. It is the only down-facing machine that makes concrete blocks in all wall-thicknesses up to 16 inches and automatically delivers the finished block away from the machine.
4. It is the only machine that makes faced concrete blocks with the same number of machine movements as blocks made of a uniform material throughout.
5. It is the only machine that allows ¼ inch space for mortar on the laying side of *every* block.
6. It is the only down-facing machine (mould boxes excepted) which makes concrete blocks at a point low enough to allow for proper tamping without bending over.
7. It is the only machine that moulds with *absolute accuracy* all the laying sides of the concrete block. The striking off is done opposite the face and thus the interior and exterior may both be faced.

***The Hayden** Automatic Concrete Block Machine, showing the finished concrete block being delivered away from the mould at a low point and with the face of the block, made face downward, delivered on the side. Note how this block is faced.*

This is the strongest and heaviest concrete block machine made—weighing 1550 pounds. With the regular equipment, including a complete line of plates, the weight is 5000 pounds—one-third greater than that of any other block machine on the market.

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RECENTLY PATENTED INVENTIONS.

Of Interest to Farmers.

COMBINED POTATO AND CORN PLANTER.—W. A. HALL, SR., Pardeeville, Wis. This improvement is in the nature of a check-row planter designed more especially for planting potatoes, but applicable also with slight modification to planting corn or other seed. It is designed to plant two or more rows at a time, and to check-row them or aline the hill both ways, and to drop one potato or piece of potato in a hill, and to adjust the distance between the rows and also the space between the hills in the row.

Of General Interest.

WINDOW-SASH.—J. B. MCKEOWN, Union Hill, N. J. This invention relates particularly to improvements in means for securing glass in fire-proof window-sash, the object being the provision in lieu of putty of a metallic securing strip or strips, the parts being so arranged that the strips may be pressed tightly against a glass of any thickness.

TRUSS.—G. V. HOUSE, Mount Vernon, N. Y. The inventor's purpose is to provide a device for the end of the belt of a truss when it connects with a pad-carrying plate so that it will cover and conceal the end of the belt connecting with the plate and at the same time partly cover the buckle or other fastening device that receives the free end of the belt, thus giving the truss a perfect finish when on the person and preventing the belt where it connects with the plate from becoming disengaged from its buckle and also preventing the latter from annoying fleshy persons.

MOSQUITO-NET.—J. W. GRAEME, United States Navy. Lieutenant Graeme's invention is a net intended for use especially on sailor's hammocks, though it may be used for sportsmen's, hunter's, or other forms of hammocks. It is especially valuable in tropical countries, particularly in ports infected with malaria and yellow fever. It can be conveniently applied for use and when not in use can be folded in compact form and lashed up in the hammock with the other bedding.

TUBE EXPANDING AND BEADING TOOL.—W. MCCORMICK, Hillyard, Wash. The invention pertains to boilers; and its object is to provide a new and improved tube expanding and beading tool arranged to quickly expand the tube in the flue-sheet opening, to form beads on the tube on opposite faces of the flue-sheet, and to give a high finish to the outer bead.

CHAIN-LINK SHACKLE.—G. A. H. DRESLER, Karlstrasse 25[11], Kiel, Germany. The object in this case is a connecting-shackle for chain-links in which the ends of the open link are held together by means of a closing member. The arrangement is such that this member is provided with recesses directed toward the interior of the chain-link and covers the connecting-studs of the link in the manner of a cap. The web or shank portion of the closing member is surrounded by a box or sleeve, which serves to reinforce the pin of the link by taking the strain.

WIRE-REEL.—W. E. EICHHOFF, Cairo, Ill. The reel winds or unwinds any kind of wire. One object in view of the inventor is the provision of means for mounting the reel to the end that it may be adjusted to a variety of positions, whereby the reel is adapted to rotate in a vertical, horizontal, or inclined plane, and provision is made for overcoming tendency of reel and its mount to tip or fall over in hillside use. He provides a wheeled truck on which the reel proper may be mounted in a detached manner, and equipped with platform for supporting extra coil of wire, tools, etc., when the reel is mounted on the truck, although the platform may be raised on the truck when the reel is dismounted, to serve as the bed of the truck.

MINER'S LAMP.—T. T. CARTER and S. J. THOMPSON, Bluefield, W. Va. The design in this instance is to provide a lamp which can be readily fitted over the cap of the miner or attached thereto. The vizor, which is of metal, will reinforce the usual cap-vizor, or it will take the place of the ordinary vizor. Means are provided so that when the miner dons his cap the lamp will be with him. The vizor and shield-plate form projecting guards for the wearer's head.

Hardware.

TUMBLER-LOCK.—N. W. WEBB, New York, N. Y. The object in this case is to provide a lock more especially designed for use as a latch or dead-lock and arranged to insure proper working of the tumbler-pins, without danger of getting out of order, by providing strong and long tumbler-pins and springs, without unduly increasing the size of the plug and keys, to prevent unauthorized persons from actuating the door-lock with a view to unlocking and opening the door.

Household Utilities.

OVEN.—H. C. G. KREUTZKAMP, New York, N. Y. In this patent the invention refers to ovens such as used for baking food. The object is to produce an oven which is specially adapted to be used in connection with a gas-stove, further objects being to provide improved means for regulating the distribution of the heat within the oven and preventing radiation therefrom.

IRON-HEATER.—C. PETTY, Bay Minette, Ala. In use the device is placed in front of such a source of heat as a fireplace, with the opening in the hood turned toward it, and then upon raising the shield the irons may be introduced and limited in inward movement or toward the fire by the fender, while they will be prevented from falling in this direction by the contact of the handle with the shield. When sufficiently hot, the shield is raised and irons removed. The irons are held out of contact with ashes and away from the influence of smoke.

SIGNAL.—M. D. CAMPBELL, Charlestown, Mass. The invention relates to signals, and more particularly to those adapted for domestic use for conveying information to tradesmen delivering goods. The signal comprises a support having an opening, a mirror mounted in the opening, a holder surrounding the opening at one side, and cards provided with perforations furnishing characters carried by the holder.

COMMODE.—W. C. FEELY, New York, N. Y. The purpose of this inventor is to provide a wheel-supported commode which may be used alone whenever needed, but which can be attached when required to the side of a bed, a couch, or equivalent article of furniture; and a further purpose is to provide a convenient means for bodily adjusting the commode, together with adjustable back and leg rests for the user. Another purpose is to provide a construction of bed particularly adapted for use in connection with the commode.

Machines and Mechanical Devices.

REGISTERING DEVICE FOR PRESSES.—W. J. RAMSAIER, New York, N. Y. While the principle of this invention is capable of many applications it is particularly designed for registering the number of impressions made by a printing-press. The principal object is to provide for accurate registration of impressions and also to prevent recording of movements of the platens of the press unless those movements result in the taking of an impression.

COTTON-COMPRESS.—W. HILL, Alexandria, La. One purpose of the inventor is to provide a construction of a compress which will stand a minimum of wear, and also to so safeguard the screw-shafts that they will be effectually protected against grit, dust, and like material calculated to injure them, and, furthermore, to provide effective means for protecting the screw-protectors against damage through careless handling of bales to be compressed.

SAW-SWAGE.—S. T. LIPSEY, Georgetown, S. C. One of the principal objects of the invention is the provision of a saw-swage adapted alike to the swaging of the teeth of band-saws, gang-saws, and circular saws irrespective of the gage thereof and also to provide means for overcoming many disadvantages and objections encountered in the use of many saw-swages hitherto devised with like ends in view.

PRESSER-MACHINE FOR BOXING PURPOSES.—G. N. POND, Aspen, Col. In packaging fruits of different kinds, as apples and pears, in boxes and the like, each box is usually filled with the fruit to a height exceeding that of the upper edge of the box for about one-half the thickness of a layer of the fruit, and when the lid is applied it is necessary to press down and hold it while securing it in place either by nailing or otherwise. The principal object of the inventor is to provide a machine for performing the work of holding down the lid while securing the same in place.

HAT-HANGER.—M. W. POTTER, Red Lodge, Mont. The invention has reference to improvements in devices for hanging hats on hooks or the like, the object being to provide a hanger adapted to be attached to a hat and so arranged as to be turned outward for engaging with a hook or the like and automatically swinging into the hat when released from the hook.

TRANSMISSION MECHANISM.—E. NELSON, New York, N. Y. This invention is especially useful under circumstances where it is desirable to transmit power at a variable velocity of rotation. The object is to produce a mechanism which will be simple in construction and which will enable a variable-speed transmission to be effected by frictional contact, and to further provide means whereby the transmission may become variable.

Railways and Their Accessories.

DEVICE FOR ACTUATING SWITCHES.—A. FULLER, Amsterdam, N. Y. In this patent the object of the inventor is to provide a device for actuating a switch-point by the motorman in charge of the car, the device being simple and durable in construction and composed of few parts not liable to get easily out of order. Means are provided to permit convenient removal of any dirt, snow, or the like accumulating in the pit below the switch-plate. The invention relates to street-railways.

SAFETY GUARD OR FENDER FOR TRAMWAY AND THE LIKE VEHICLES.—P. LENTZ, 34 Sternstrasse, Gross Lichterfelde, near Berlin, Germany. This device or guard is for trains and the like, the catching apparatus of which is suspended from rocking rods by means of joints. The catching apparatus is connected with the supporting-frame at the rear end by means of intermediate links in such manner that upon being pressed back by the obstacle its rear end is raised so that its front end is lowered onto the track so that the catching apparatus is readily able to receive person or object in danger and so that no injury can be occasioned thereto.

COMBINED STRAP-HANGER, SIGNAL-BELL RINGER, AND REGISTER-RINGER.—S. S. BROOKS, Brooklyn, N. Y. When the sections of the strap-rail are in place they form a continuous rail supported in very efficient manner by the oppositely-disposed attaching-arms of the brackets. The parts of the rail are easily assembled, one section being fixed in place, after which remaining sections may be easily adjusted with respect thereto. The rail is also capable of indefinite expansion or may be made as short as required.

GRAIN-DOOR—W. J. COCKLIN, Rising City, Neb. The invention pertains to a door for freight-cars of the "box-cars" type, by which door the cars may be rendered sufficiently tight to permit loading grain in bulk. The object is to simplify the construction of the door, render it stronger or more durable, and permit it to be readily folded, so that it will not interfere with using the car for other freight.

Pertaining to Vehicles.

VEHICLE-BODY.—W. W. OGDEN, Chatham, and W. C. YELTON, Newark, N. J. Means are provided by this improvement for joining either aluminium, steel, copper, or any other metal panels together and to the wooden frame of vehicle-bodies to avoid former objections—in other words, to provide a waterproof shell, add to stiffness and rigidity of structure, and afford absolutely smooth and uniform outer surface for shell and adjoining strip. This is accomplished by improvements in the frame and joint-strip, which co-operate with each other to secure the desired result.

Pertaining to Recreation.

GAME-COUNTER.—O. W. FIELD, Chicago, Ill. The invention refers more especially to counters adapted for use in connection with games, as billiards and the like. A casing or supporting frame is employed in which are operatively organized a plurality of preferably horizontally-alined counting members, each having independent movement in or on guides therefor within the casing, to be brought to position to indicate or register a particular number of points of the game.

Designs.

DESIGN FOR A BADGE.—W. C. MARTEN, Carbondale, Ill. Within the borders of this ornamental badge are arranged in upright crossed positions an axe and a wooden maul on a log of wood. A wedge is balanced between these implements. Surmounting all are the letters "W M A." Three links of heavy chain extend partly around the bottom of the badge, and between the log and chain are the letters "I O O F."

DESIGN FOR A CASING OF VENDING-MACHINES.—J. E. CAHILL, Baltimore, Md. This ornamental design simulates an elephant, the elephantine form being represented in standing position, with head raised, mouth and throat widely distended, short tusks joining sides of the mouth, ears projecting laterally, and the trunk raised high and thrown backward and to one side.

NOTE.—Copies of any of these patents will be furnished by Munn & Co. for ten cents each. Please state the name of the patentee, title of the invention, and date of this paper.

Business and Personal Wants.

READ THIS COLUMN CAREFULLY.—You will find inquiries for certain classes of articles numbered in consecutive order. If you manufacture these goods write us at once and we will send you the name and address of the party desiring the information. **In every case it is necessary to give the number of the inquiry.**

MUNN & CO.

Marine Iron Works. Chicago. Catalogue free.

Inquiry No. 8065.—For builders or manufacturers of the evaporative condenser.

For mining engines. J. S. Mundy, Newark, N. J.

Inquiry No. 8066.—For dealers in argillaceous slate; also for makers of rag paper paste.

"U. S." Metal Polish. Indianapolis. Samples free.

Inquiry No. 8067.—Wanted, the makers of the placket fastener called "C-curity."

I sell patents. To buy, or having one to sell, write Chas. A. Scott. 719 Mutual Life Building, Buffalo, N. Y.

Inquiry No. 8068.—For manufacturers of a sheet of substance such as paper or fabric, one side of which is to be paraffined or oiled, and the other side of which is to be coated with a glutinous glycerine substance.

Well gotten up typewritten letters will increase your business. $2 per 1,000.

Typewritten Letter Co., St. Louis.

Inquiry No. 8069.—Wanted, makers of printing presses, in Canada.

Four Patents for Sale or Trade.—Copies, models, prospects, information furnished. James E. Bennett, Box 124, Momence, Ill.

Inquiry No. 8070.—Wanted, makers of sliding partitions or screens.

I have for sale the U. S. and all foreign rights of new patent Improvements in Water Tube Types of Boilers. Great economizer. J. M. Colman, Everett, Wash.

Inquiry No. 8071.—Wanted, makers of boxes, bottles, etc., for toilet preparations, such as tooth powder, paste, etc.

The celebrated "Hornsby-Akroyd" Patent Safety Oil Engine is built by the De La Vergne Machine Company. Foot of East 138th Street, New York.

Inquiry No. 8072.—Wanted, address of manufacturers of secondary electric clock movements for one minute impulse.

Manufacturers of patent articles, dies, metal stamping, screw machine work, hardware specialties, machinery tools, and wood fiber products. Quadriga Manufacturing Company, 18 South Canal St., Chicago.

Inquiry No. 8073.—For manufacturers of graduating machinery, such as is used to graduate scales, squares, etc.

Automobile experts are in constant demand at high salaries. Our seven weeks' course is the most thorough and practical, fitting men to drive, handle and repair. Day and evening classes. Special course for owners. New York School of Automobile Engineers, 146 West 56th Street, New York.

Inquiry No. 8074.—Wanted, small friction and screw top tin cans, wooden mailing cases and small brushes.

WANTED.—Articles to manufacture in either wood or iron, by well-equipped foundry and machine shop. Ypsilanti Machine Works, Ypsilanti, Mich.

Inquiry No. 8075.—For manufacturers of machine suitable for grinding divi-divi.

Inquiry No. 8076.—For manufacturers of machines used to make rugs from old carpets.

Inquiry No. 8077.—For manufacturers of umbrella ribs.

Inquiry No. 8078.—For manufacturers of machinery for weighing and sealing paper packages of cereals of one and two pounds weight, and also machinery for printing on canvas bags in two colors.

Inquiry No. 8079.—Wanted, address of companies who mold electrose or imitation hard rubber.

Inquiry No. 8080.—For manufacturers of metallic calcium.

Inquiry No. 8081.—For manufacturers of machinery for working agricultural and road forks.

Inquiry No. 8082.—Wanted, address of manufacturer of Gardiner Gyroscope.

Inquiry No. 8083.—For manufacturers of metal as thin as tin foil or thinner.

Inquiry No. 8084.—Wanted, address of makers or patentees of apparatus or system for drying fruit, in which the air passing through is first freed of its moisture by contact with concentrated sulphuric acid, running down a series of shelves arranged in tower fashion.

Inquiry No. 8085.—Wanted, makers of automatic lathes for pill and ointment boxes, tack barrels, etc.

Inquiry No. 8086.—For manufacturers of stump sawing machines.

Inquiry No. 8087.—For manufacturers of emery wheels, such as are clamped on fly wheel of a sewing machine.

Inquiry No. 8088.—For manufacturers of a transfer press.

This is a reproduced photograph of the Weldon Apartment house at Greenfield, Mass., built of Cement Stone made on the Hercules.

Done On the Hercules

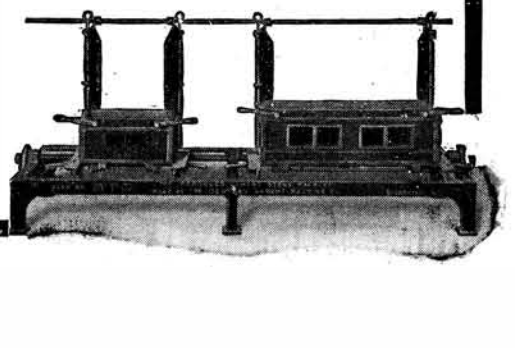
THE WORLD'S GREATEST CEMENT STONE MACHINE

On this Machine, so simply constructed, the most marvelous results are obtained. It will make solid or hollow blocks, pillars, sills, lintels, coping, or ornaments of any kind, from 2 inches up to 6 feet. It will make two blocks of the same size and design, or of different sizes and designs at one and the same time.

The Hercules will make more stone and better stone in less time and for less money than any other machine. We can't prove that statement here, but if you will take the trouble to send for our handsomely illustrated 68-page catalog, it won't take but a few minutes to convince you—Ask for Catalog No. 2.

CENTURY CEMENT MACHINE CO.

303 W. Main Street ROCHESTER, N. Y.



Barrett Specification Roofs

FEW things are as annoying and expensive as leaky roofs—and few things are as *unnecessary*. The damage which they cause (and it amounts to thousands of dollars annually) is due almost entirely to the fact that buildings are roofed with materials which, unless painted every two or three years, quickly rust out and leak.

A BARRETT SPECIFICATION ROOF not only requires no coating nor painting, but any reputable contractor will guarantee such a roof for at least *ten years* absolutely. Behind this guarantee is a record of fifty years of satisfaction on buildings of every kind all over the country.

The photographs opposite give some idea of the variety of structures for which Barrett Specification Roofs are particularly adapted.

No. 1—N. Y. C. & H. R. R. Freight Station at St. John's Park, New York. Roofed 36 years ago, and the roof to-day is in good condition.
No. 2—The Auditorium Hotel at Chicago. One of the largest hotels in the country.
No. 3—The Studebaker Plant at South Bend, Ind., covered with over 800,000 square feet of Barrett Specification Roofs.
No. 4—Massachusetts Cotton Mills, at Lowell, Mass., roofed in 1874 and in good condition to-day. Area 700,000 square feet.

And of importance to every man who pays the bills is the fact that the *cost* of a Barrett Specification Roof is less than one of Tin or metal of any kind and its life very much longer.

The Barrett Hand Book covering thoroughly the subjects of roofing and waterproofing will be mailed free on application.

BARRETT MANUFACTURING CO.

NEW YORK CHICAGO ALLEGHENY CLEVELAND ST. LOUIS BOSTON
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THE STANDARD AMERICAN BRAND

Atlas Portland Cement

ALWAYS UNIFORM

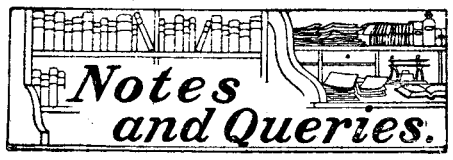
Specified by All Leading Architects and Engineers

Portland Cement Concrete has become the recognized building material where strength, durability, and fire-proof qualities are demanded. From a residence to a factory, from a sidewalk to a bridge, there is no other building material that will give such satisfactory and permanent results. The wealth of beauty obtainable in Concrete architecture and design is in marked contrast to the low cost of Concrete Construction.

The Atlas Portland Cement Co.

30 Broad Street, New York

Our new booklet, "Concrete Construction About the Home and on the Farm," sent free on request



HINTS TO CORRESPONDENTS.

Names and Address must accompany all letters or no attention will be paid thereto. This is for our information and not for publication.

References to former articles or answers should give date of paper and page or number of question.

Inquiries not answered in reasonable time should be repeated; correspondents will bear in mind that some answers require not a little research, and, though we endeavor to reply to all either by letter or in this department, each must take his turn.

Buyers wishing to purchase any article not advertised in our columns will be furnished with addresses of houses manufacturing or carrying the same.

Special Written Information on matters of personal rather than general interest cannot be expected without remuneration.

Scientific American Supplements referred to may be had at the office. Price 10 cents each.

Books referred to promptly supplied on receipt of price.

Minerals sent for examination should be distinctly marked or labeled.

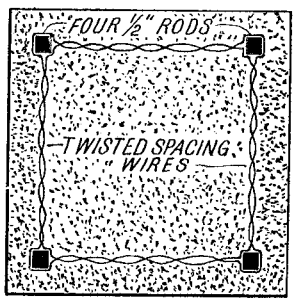
(9965) R. B. asks: Could you please tell me why a lamp chimney becomes heated when placed on a lighted lamp, glass being diathermanous for luminous rays of heat? A. A lamp chimney becomes heated because there is a hot mass of matter inside it. So does the earth's atmosphere by the sun's rays. The atmosphere absorbs about 40 per cent of the rays of the sun, so that they do not reach the earth at all. The flame of a lamp is luminous from solid particles of carbon in the flame. This radiates heat. The glass intercepts much of that heat, and by this it is itself heated. There is no substance which can transmit all the heat which strikes it. Glass becomes hot in the sun's rays.

(9966) H. N. asks: The ground is frozen about two feet deep in winter, and water pipes buried four feet and imbedded in sawdust are secure from frost; but in spring, when the surface of the ground for several inches deep has turned to mud and the air is quite warm, the troubles begin with the pipes freezing. I am told that the frost travels downward when warmed above. What is the scientific explanation? The warmer the weather gets, the worse the pipes freeze. A. We have never before heard of the phenomenon you describe, that frost penetrates the earth deeper in the spring after the surface begins to thaw. We suggest certain considerations which may help to a solution of the problem. Ice is a non-conductor of heat. When the surface of a lake is covered with ice, freezing of the water on the under side of the ice goes on very slowly. The same is true of the earth under snow and ice or frozen ground. Hence the frost does not penetrate as deeply as it would upon an open and dry surface of ground. After the surface snow or ice has thawed, the earth and frozen ground below are still several degrees below freezing, and as the cold water from the surface settles into the earth deeper and deeper, it freezes again below the frost line, when the ground was covered with a solid layer of ice and snow, which protected it from deep freezing during the winter.

(9967) C. W. B. asks: 1. Will you kindly answer through the columns of your valuable paper the following question: Specific gravity of a liquid showing 60 deg. gravity by Baume hydrometer and temperature 60 deg. F. Would that be 0.6 gravity, or is it 60-180 gravity, 180 being the difference between the point at which water starts to freeze (32 deg.) and starts to boil (212 deg.)? If neither, will you kindly explain what per cent 60 gravity would be by the Baume hydrometer? A. The Baume scale is graduated in equal spaces. It does not give specific gravities at all. A different scale is used for liquids heavier than water from what is used for liquids lighter than water. Thus 60 deg. Baume would be a specific gravity of 1.652 for a substance heavier than water, and 0.745 for a substance lighter than water. There are two 60 deg. in the Baume scale. 2. What is the atmospheric pressure to the square inch on the top of Pike's Peak? At what temperature does water start to boil on the Peak? A. Pike's Peak rises 14,147 feet above the sea. When the barometer is at 30 inches at sea level and the thermometer at 32 deg., at the top of Pike's Peak the barometer would stand at 17.5 inches, and water would boil at 185.9 deg. F. The pressure of the atmosphere under the same conditions would be 8.575 pounds per square inch.

(9968) G. B. asks: Is there a Portland or a hydraulic cement made which on being mixed with the proper proportions of sand and water can at once be dropped into the bottom of a lake of water and will set and harden there just as good as though it were used above water? Is there a hydraulic lime for such purpose? A. Replying to your inquiry, we would say that there are several hydraulic cements and lime which will harden under water in the manner you describe. Hydraulic lime is like common lime except that it will harden under water. Artificial lime can be made by mixing together in suitable proportions thoroughly slaked common lime and unburnt clay, tempering the mixture with water, and then burning it in the form of bricks or rounded balls in an ordinary lime kiln. With mortars of hydraulic lime the volume of sand should not be less than two times that of the lime paste, in order to secure the best results regardless of cost. The usual proportions are, however, the same as in common mortars. Hydraulic cements, in mortars of proportions varying from one part cement and two parts of sand to one part cement and four parts sand, set better and attain a greater strength under water than in the open air; in the latter, owing to the evaporation of the water, the mortar is liable to dry instead of setting. This difference is very marked in dry hot weather.

(9969) R. L. B. says: I have been using cement and concrete for fence posts, but have found these posts so weak and brittle that they were useless. I have heard that cement may be used successfully for this purpose. Please explain to me how this may be done. A. In reply to your question, we would advise you to use concrete and not cement, as the former is much cheaper. We would recommend the following mixture for your gate posts: 1 part Portland cement, 3 parts sharp sand, 5 parts fine crushed stone or clean gravel. In order to give the posts the necessary strength, whether they are made from concrete or cement, it will be necessary to reinforce them with steel rods. This can be done by means of a good-sized rod passing through the center of the post, or better by means of four smaller rods placed near the four corners of the post, as in manner indicated in cut. If four rods are used, it will be necessary to employ some device to keep the rods properly spaced as the concrete is tamped into the mold. A simple method would be to use strong twisted wire spaced so as to come either end of post, and also in the middle if the post has considerable length.



(9970) R. D. O. says: I would like to have you tell me whether it is practicable to build a fireplace out of concrete. Will it withstand the action of fire as well as brick? How thick should the walls be to protect the studding in the adjacent walls, as it is to be built in a finished house, and the woodwork cannot be made to accommodate it? A. Concrete will not stand the heat of a fireplace, due to the fact that after it is thoroughly dried out, as it will be in such a place, it will tend to crumble away. It may be used around a fireplace very satisfactorily, provided the portions of the fireplace which are in contact with the fire in any way are protected by a lining of firebrick.

(9971) A. A. T. says: I want to know how to mix up Portland cement, and what to put in it to make concrete plaster 1½ inch thick, 12 inches wide, and 4 feet long, to hold up a weight of 150 pounds, the plates to be supported at each end. Would it be advisable to make them with a support underneath? I want to make something that will do away with lumber for greenhouse benches. A. It will be possible for you to use concrete slabs of the size you mention; but, in order that they may support the weight you intend placing on them, it will be necessary for you to use at least two pieces of one-half inch round or square iron through the slabs. The proportions for you to use are: 1 part Portland cement, 2 parts clean sharp sand, 3 parts fine crushed stone. In order that the rods may be held in place while in the mold, it would be better to wind stiff wire around them so as to keep them properly spaced.

(9972) L. H. H. asks: 1. What size spark ought an induction coil give in order to give satisfactory service on a one-mile wireless telegraph "line"? A. A coil giving a 4 or 6-inch spark will work over a distance of one mile for wireless signals under ordinary circumstances. You will find a 4-inch coil described in SUPPLEMENT No. 1527, and one for a 6-inch spark in SUPPLEMENT No. 1124, each 10 cents. 2. What is a polarized relay? A. A polarized relay is one with permanent magnets, so that the armature is easily drawn over as soon as the current starts. 3. Would a 150-ohm relay such as used on commercial lines work on the above-stated wireless telegraph line? A. We think a 150-ohm relay will be sufficient for a distance of one mile.

(9973) J. C. L. writes: In answering question No. 3 of No. 9938 under Notes and Queries in your issue of April 7, page 294, it is necessary for your reader to have clearly in mind the meaning of the word "tide." The word *tide* as used by sailors at sea means *horizontal* motion of the water; but when used by landsmen or sailors in port, it means *vertical* motion of the water. The primary phenomenon of the tides is, after all, the tidal current, for it is the tidal currents that are referred to on charts, where we have arrowheads and co-tidal lines. They begin from slack water, or no current, and requiring three hours to attain a maximum as given, they immediately slack off again during another three hours, until another slack water is reached, and so on, making four times of slack water every lunar day. In the Caribbean Sea we have practically no tide the year round, the vertical motion never exceeding ten inches when free from wind effects. Where tidal currents come from opposite directions and meet we have the heaped-up effect, with scarcely any tide at all, seen at a point on the southeastern coast of Ireland and on Vineyard Sound between West Chop and East Chop just before you get to Cottage City. The average maximum tide at East Chop is only about nine inches, and at West Chop is even less than that; so much so, that we often find the water higher at low tide than at high tide. This is due to the wind driving the water to a greater height than the height due to the tidal effects. Although the tide is so small, the current is considerable. It is because the tides work in both directions, that the currents there are so treacherous. Along East Chop the tide will be running out on one side of the shoal and coming in at the other, thus producing a cross current over the shoal which causes a great many disasters. A. Certainly the word "tide" has a large number of meanings. It implies three days or a week in "Whitsuntide" and the holidays in "Christmastide." It applies to the motion of water in "ebb" and "flood" tide, and to currents generally in such phrases as a "strong tide." But there can be no doubt that the general sense which admits of no misapprehension is the astronomical sense of the rise and fall of the water in the semi-diurnal motion of a wave over the oceans of the earth. In this sense we always use the simple word; if we wished to refer to a current, we should say a tidal current. We have usually found seafaring men employing the word in the same sense as we have employed it. Indeed, we often find our language colored by the long experience we have had at sea and among sailors. Our correspondent in his letter uses tide and tidal currents in the same senses as we do. The instances he gives are of interest, and are the ones we should have cited had we gone more fully into the subject than we did

(9974) A. J. K. asks how to make solid emery paper. A. Emery paper is frequently found lacking in retaining an equal efficiency, the fresh parts biting too much, and the paper getting soon worn through in many places. Emery has been tried on linen, but with little success. A paper or board has been recommended in which emery enters as a constituent part. It is advised to employ fine and uniform cardboard pulp, with one-third to half its weight of emery powder thoroughly mixed with it, so that the emery may be equally distributed. The mass should be poured out into cakes of from 1 to 10 inches in thickness. They must not be pressed hard. Such a paper, it is said, will adapt itself to the form of the articles and will serve until completely worn out.

(9975) G. W. S. asks: 1. What causes the percentage of oxygen in the air to remain constant when such enormous quantities are being constantly consumed by animals and direct combustion? A. The plant world takes the carbon dioxide which animals exhale and breaks it up again, forming other products and restoring the oxygen to the air again. The processes of nature balance, and there is as much decomposition as there is formation in the long run. 2. Will not a given tank or reservoir empty itself more rapidly of water if provided with a vertical outlet pipe extending in a downward direction and of considerable length, than if provided with the same size hole discharging directly into the air? Would not the increasing velocity of the water as it falls through the pipe cause a partial vacuum in the upper part of the pipe, thus drawing the water out of the tank more rapidly? A. The quantity of water discharged through a vertical pipe is not increased by lengthening the pipe. As the velocity of the falling water is increased, the stream leaves the sides of the pipe and has a smaller cross section. Thus there is an air space around the water in the lower part of the pipe, and the water does not fill any vertical pipe through which it flows freely. You could not draw water out of the side of such a pipe. This would prove that the pipe was not full of water. There is no pressure on the side of such a pipe.

NEW BOOKS, ETC.

BOOKKEEPING BY MACHINERY. By Erwin W. Thompson. New York: Published by the Author, 1906. 8vo.; pp. 176.

While manufacturing establishments undoubtedly seek to install the latest and most highly perfected machinery in their shops and factories, these same corporations seldom trouble themselves to similarly eliminate hand work in their offices. They appear to look upon the employment of an army of clerks as a necessary evil. In the latter case the use of machines has been mostly limited to typewriters, letter presses, duplicating machines, and an occasional adding machine, and not many offices have their mechanical devices properly co-ordinated. "Bookkeeping by Machinery" is the title of a new book, which describes the use and co-ordination of the various means of mechanical computation now on the market, and shows that much of the drudgery of bookkeeping may actually be performed by machinery in a more accurate and rapid manner than by hand. The book is barely free from the general tendency, conscious or otherwise, to lapse into catalogue phrases, but produces the impression of having been written from the standpoint of the user rather than the maker of the machines.

ASPHALT INDUSTRIE. By Felix Lindenberg. Vienna: A. Hartleben's Verlag, 1906. 12mo.; 46 illustrations; pp. 320. Price, $1.50.

The author has undertaken in this book to describe in an extended manner the characteristics and the production of natural as well as artificial asphalt, and has included discussions of the manifold uses of which this material is capable. The description of the value and practicability of asphalt in connection with building operations is as thorough as the importance of this aspect of the subject warrants. He also includes an entire series of uses of asphalt, which serve as the foundation for other and different industries, such as, for instance, the manufacture of tiles and insulating plates, of tubes of asphalted paper or wood, of pavements, etc. This book will doubtless prove its value to the asphalt manufacturer and user, as well as the technical man in other fields of industry.

CHEMISTRY OF THE PROTEIDS. By Gustav Mann. London: Macmillan & Co., 1906. 8vo.; pp. 606. Price, $3.25.

This elaborate and thorough book on this interesting and important branch of chemistry, while based to a great extent on Cohnheim's "Chemie der Eiweisskörper," is nevertheless, largely original, particularly in the later developments of this abstruse subject. While much of the contents is interesting purely from a scientific standpoint, the work will be found of value in many industries dealing with chemistry. The author's experience in his profession and his familiarity with the latest productions and developments therein have enabled him to write a treatise which is not only thorough, but which is clear and as concise as the magnitude of the subject permits. The author's references to quoted authorities are carefully executed throughout.

HEAT AND LIGHT FROM MUNICIPAL AND OTHER WASTE. By Joseph G. Branch, B.S., M.E. St. Louis, Mo.: William H. O'Brien Printing and Publishing Company, 1906. 8vo.; pp. 305; 56 illustrations.

It is undoubtedly true that despite vast expenditures of money, many of our American municipalities are far behind those of Europe in the solving of economic problems concerning the safety and health of their citizens. Particularly is this true in the case of the disposal of municipal and other waste, and the importance of the subject is commensurate with the fact that there is no more serious menace to the health of any community than its refuse. The author of this book deals with the subject from the standpoint of the statistician, the investigator, and the expert, and furnishes many valuable suggestions, not only for the improvement of existing methods and systems, but for the development of others as well. That these improvements are of the most pressing necessity can be gathered from the fact that the disposal of refuse in foreign cities rarely exceeds one cent per capita, while in only one American city, New York, is this figure even approached. In the latter case the cost is two cents per capita, while in the remaining large cities of the United States the cost ranges from twenty-three cents to forty-four cents. The reason for the great difference is the utilization or lack of utilization of the incinerated wastes for the production of heat and light.

MODERN MACHINE-SHOP CONSTRUCTION, EQUIPMENT, AND MANAGEMENT. By Oscar E. Perrigo, M.E. New York: The Norman W. Henley Publishing Company, 1906. 4to.; pp. 343. Price, $5.

This work, which goes into the matter of building, equipping, and managing a modern machine shop or manufacturing plant, is a large and interestingly-written volume illustrated with over 200 detailed diagrams. The book is in three parts, the first of which treats of the construction of such a shop and describes and illustrates buildings of approved form and arrangement. The second part deals with the equipment of the shop with modern tools, machines, and appliances; and the division of the plant into the proper departments for administrative and mechanical purposes. Part III. treats of the all-important question of management, and discusses some of the so-called management and time-and-cost systems, while at the same time putting forward a plain, concise, and accurate system of this kind which may be economically administered and which will give all the important information necessary for operating a business with financial success.

Much of the subject-matter of the book was originally published in Machinery, The Iron Trade Review, and The Foundry, and was read with much interest by practical men engaged in manufacturing enterprises. Besides revising and rewriting a considerable portion of this material, the author has added ten new chapters. The work will be found of great value to manufacturers and practical shop men, as well as to technical students in the pursuit of information on the subjects of which it treats.

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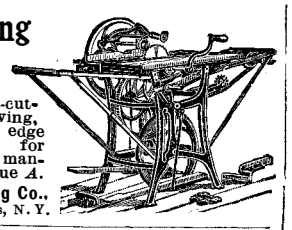

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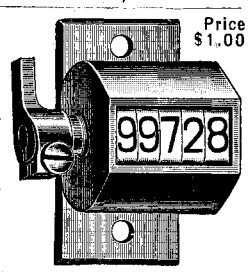

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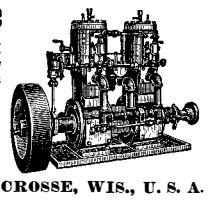

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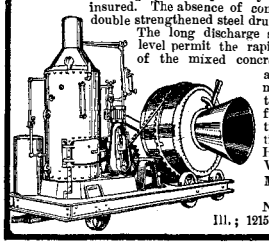

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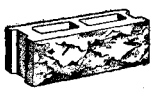

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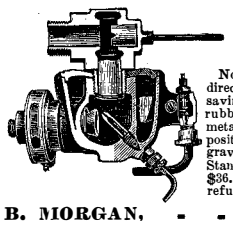

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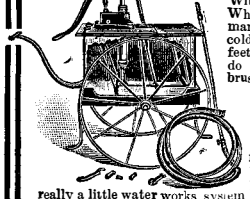

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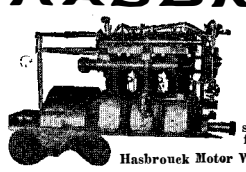

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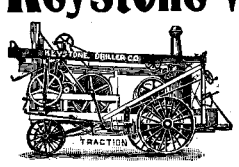

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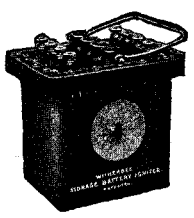

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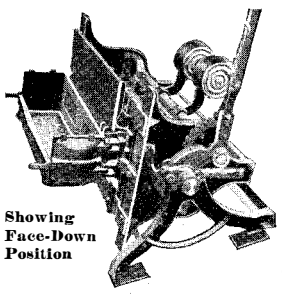

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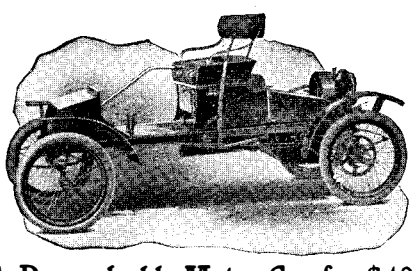

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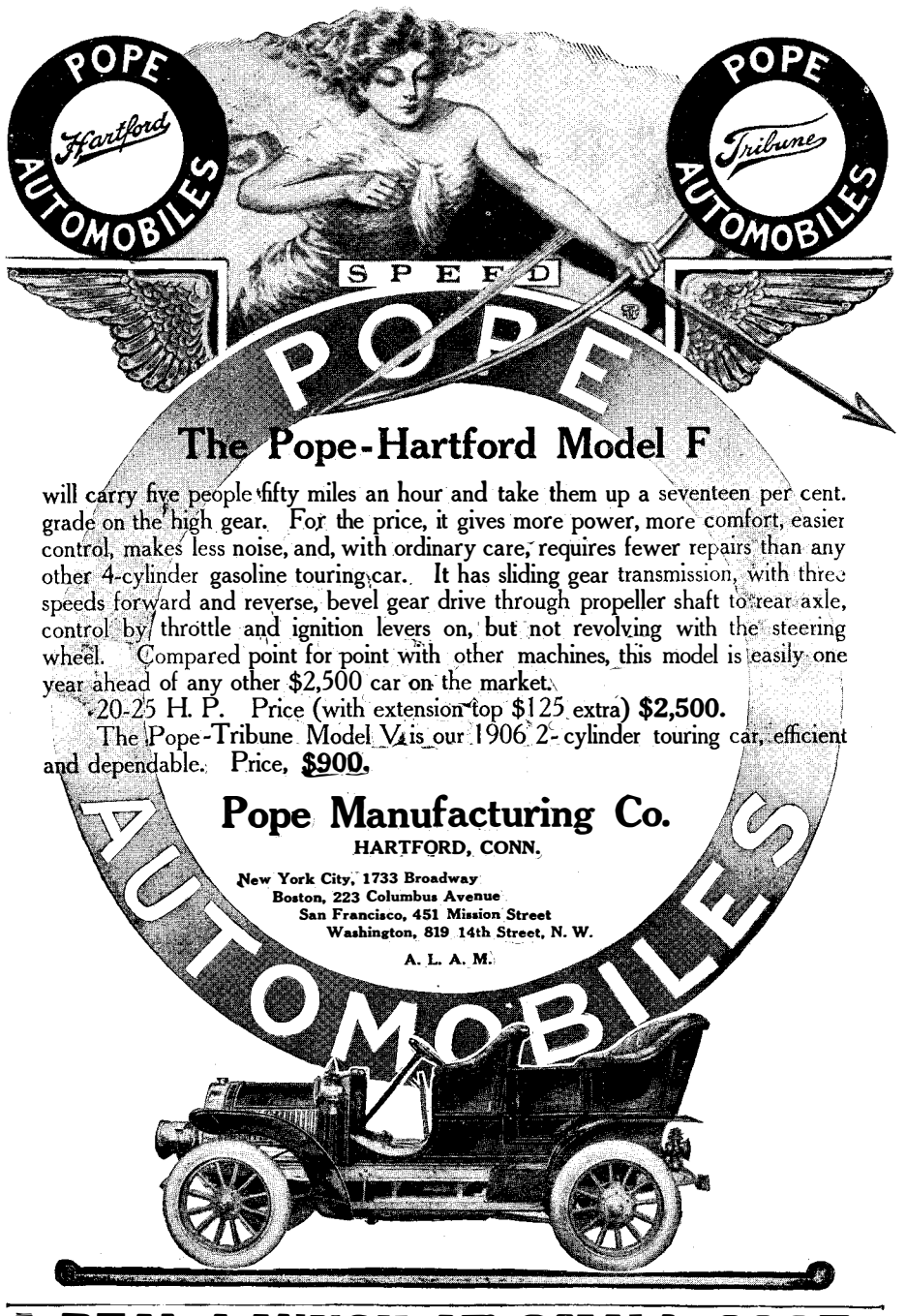

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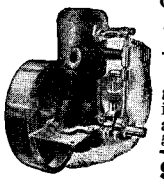

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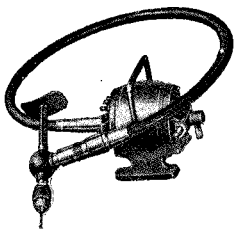

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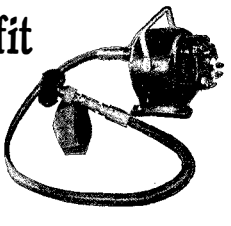

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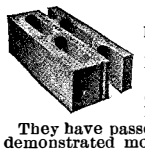

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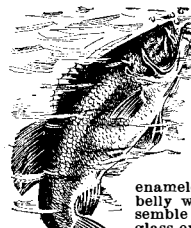

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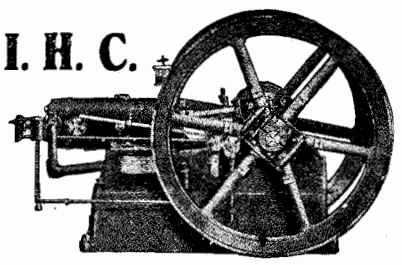

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Scientific American Supplement 1551 contains the principles of reinforced concrete with some practical illustrations by Walter Loring Webb.

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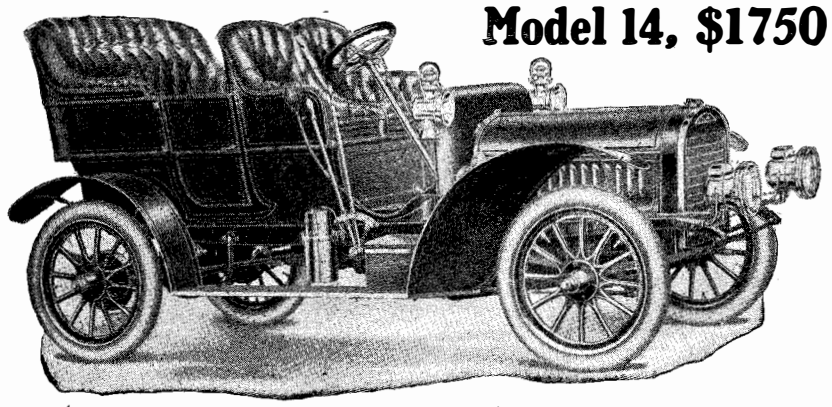

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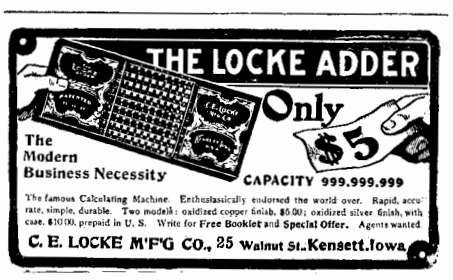

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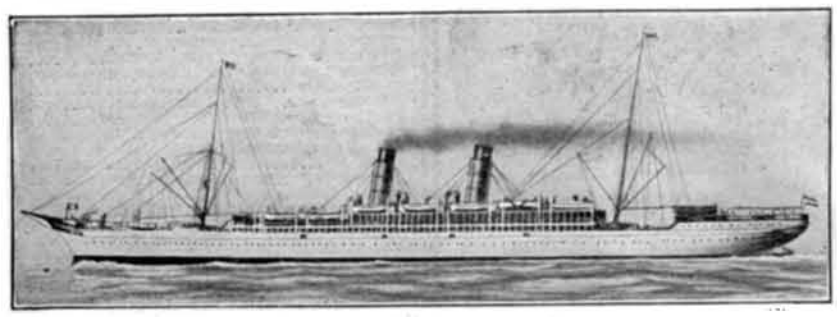

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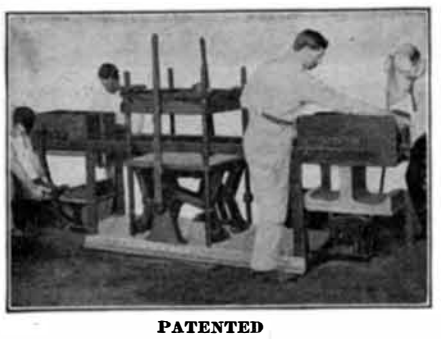

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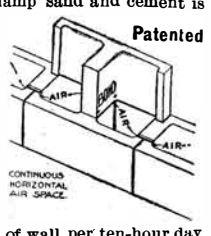

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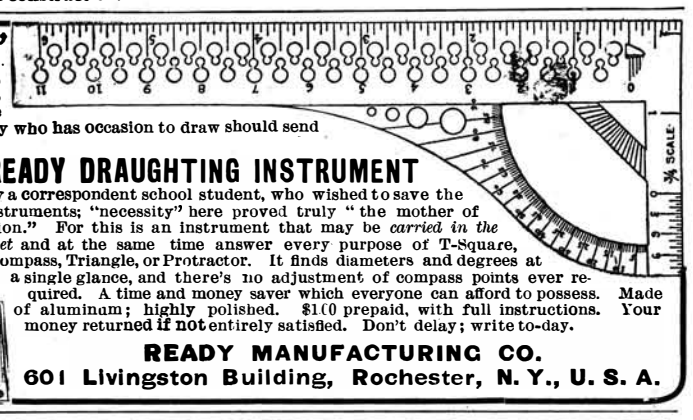

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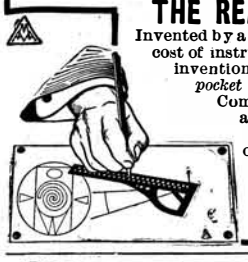

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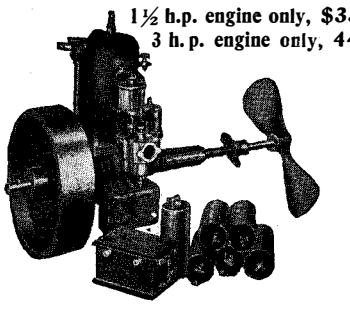

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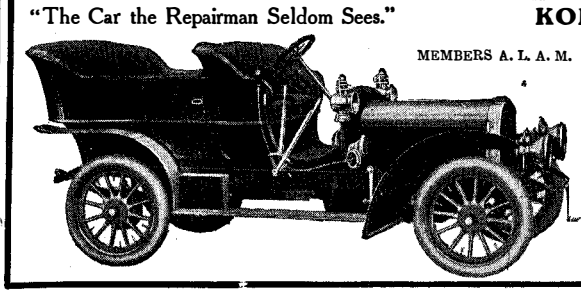

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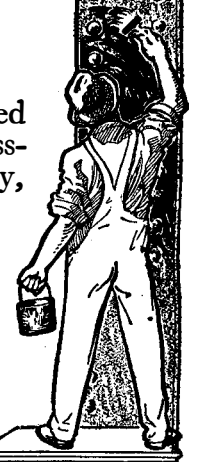

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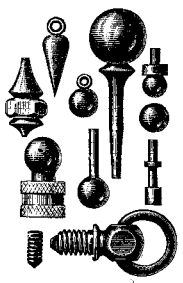

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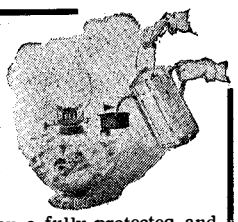

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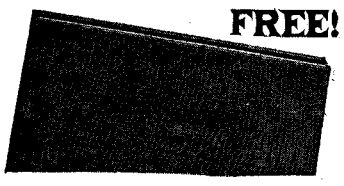

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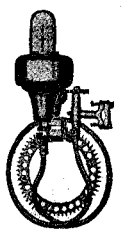

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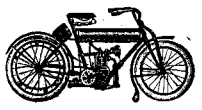

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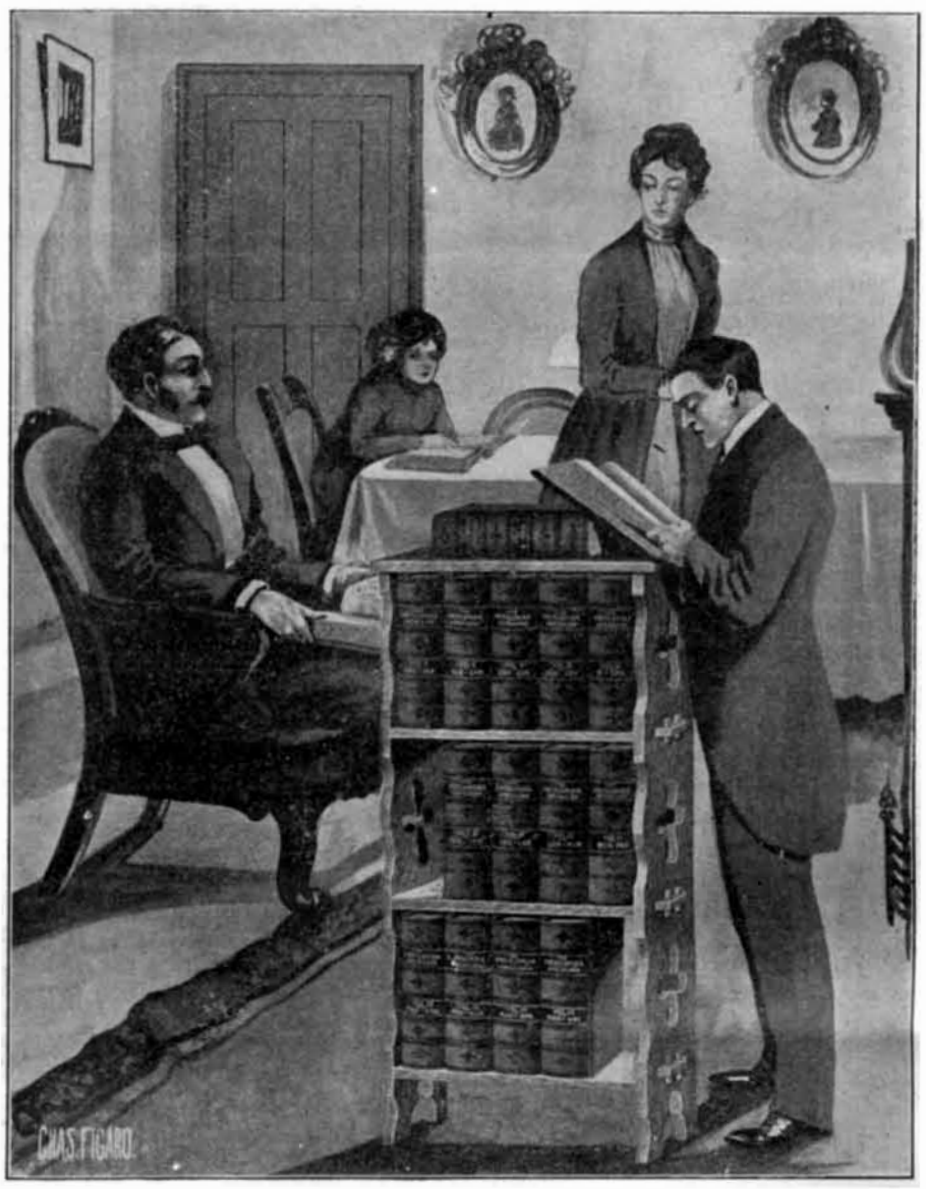

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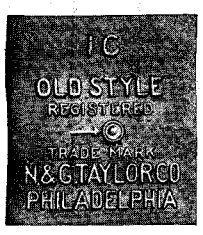

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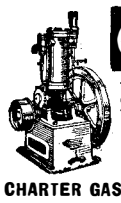

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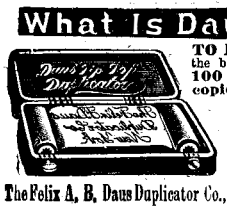

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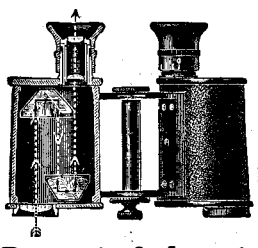

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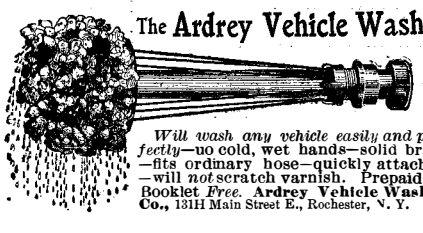

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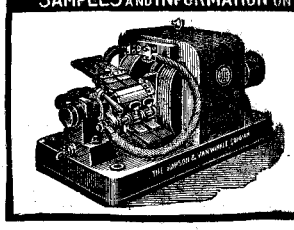

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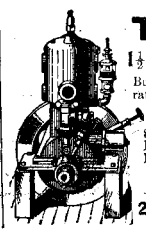

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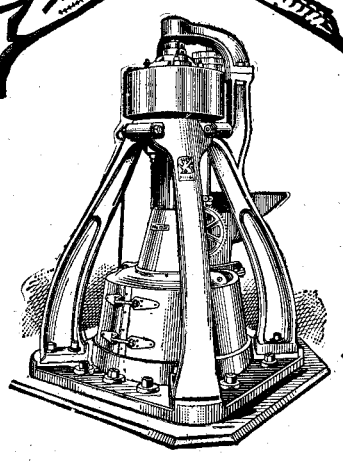

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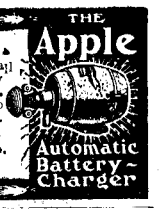

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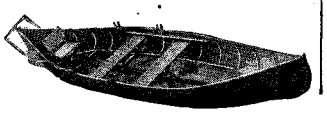

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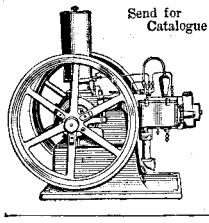

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